AN EVALUATION OF A SINGLE STANDARD, SINGLE IMAGE RATING AID FOR TIME STUDY RATING

A Thesis

Submitted to the Faculty

of

Purdue University

by

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In Partial Fulfillment of the

Requirements for the Degree

of

Master of Science in Industrial Engineering

June, 1950

ACKNOWLEDGEMENTS

Sincere appreciation is expressed to Dr. M. E. Mundel for his generous advice and counsel, and to the group of seventy-three industrial engineers who gave their time and interest in order to provide the data necessary for this appraisal of time study rating techniques, and to the staff of the Division of Technical Extension of Purdue University who so efficiently handled the clerical details of the Fifth Annual Time Study Work Session.

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ABSTRACT

The purpose of this thesis was to obtain data with which to evaluate the single standard, single-image rating aid in order to determine the accuracy of the assigned ratings and the consistency of those ratings when using this aid.

As additional objectives, an attempt was made to determine whether or not rating ability when using this aid is affected by the experience in the field of time study, the size of town in which company is located, the number of employees in the plant, the rating concept of the observer, and the geographical area in which the observer is employed.

A single standard, single image loop rating aid allows the rater making the time study to compare visually, at the same instant, the operator's pace against the standard pace as given by the bench mark film. It is suggested that this visual aid of a single standard pace will allow the rater to determine the operator's deviation from that standard pace more accurately and would also increase the consistency of the rating.

The films that were rated consisted of eighteen films of six different actual factory operations, each of the operations being performed at three different rates of activity. The eighteen films were shown in random order alongside the single loop aid. The single image loop rating aid was the standard bench mark for 100% pace.

The preidentified mark-sensing IBM cards marked by the observers were later punched with additional pertinent information taken from the questionnaires filled out by each rater.

With this additional information it was possible to obtain and analyze the ratings of the entire group in respect to any of the items on the questionnaire.

An analysis of the data revealed that in the entire group, 33% of the raters were within ±5% of the best approximation of the correct ratings, while 39% were within ±5% of the group average. This indicates that on the first application of this new method of rating, the average rater did as well or better, in both accuracy and consistency, as he did using his own method of rating. This suggests that with practice, the accuracy and consistency of the ratings using the single loop aid may well surpass those obtained by the conventional methods.

The accuracy and consistency of the ratings assigned when using the single loop aid does not correlate with any given degree of time study experience, the place of initial time study training, the number of employees in the plant, the method of rating, nor the size of the town in which the company is located. The geographical area of the observer does not reflect in any way on the accuracy of the ratings; however, due to familiarity with the single image rating technique, the Michigan group of raters were somewhat better in the consistency of their ratings.

These results indicate that the single loop aid tends to eliminate any possible differences in accuracy and consistency caused by the previously mentioned factors by providing a single concrete standard that is the same for any number of observers.

operation.

Those involved indicate that the single load will range in
capacity from 2 million gallons to approximately one-quarter
of the recently constructed 1 million kl capacity
single-cell reservoir. This reservoir will be the largest
concrete structure ever built in the state for water
storage.

Since completion of the dam embankment at these earthen
reservoirs, the storage capacity of the single load will be
reduced by approximately 10 percent due to sedimentation.
Plans have been made to remove the sediment by dredging.

The construction and construction of the existing single
cell reservoir took one year and cost approximately $1.5
million. This compares with the estimated cost of $2.5
million for the two-cell unit. The reservoir was
constructed of the materials which are readily available
from the site. This method of construction is not
applicable to the multi-cell reservoirs.

The reservoirs at the dam currently rest in the Bonita Creek
and of the two-cell unit is the only impoundment of
water. This reservoir lies on the first tributary of Bit
Bon Bottom of Bonita, the nearest water dig is well to
the north. This reservoir will be the only water for many
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many

AN EVALUATION OF A SINGLE STANDARD, SINGLE IMAGE RATING AID FOR TIME STUDY RATING

INTRODUCTION

When time studies were first introduced in industry, the unions regarded it as just another adjunct to forcing the last ounce of effort out of the workers without any consideration of their physical welfare. Unfortunately labor had some justifiable grounds in its accusation, for time and motion study had its birth in the era of "efficiency experts" where unscrupulous engineers attempted to increase productivity through unreasonable requirements of physical performance and speed-ups. This was, of course, directly contrary to the objectives and principles of the unions; hence, time and motion study acquired in its infancy the opposition of labor. It has taken many years to change the attitude labor erroneously acquired about time studies. Only through the dissemination and complete explanation of the principles of scientific time study throughout the field of labor, have the workers gradually come to realize that sound time studies may provide real benefits in the form of simplified work and reduced hazards, discomfort, and fatigue. In obtaining the confidence and cooperation of the labor unions, exacting principles for all phases of time and motion study must be formalized so that they may be scrutinized and accepted or rejected by the representatives of labor. There can be no guessing on any phase of human

performance; the phenomenon to be judged must be in concrete form and the same for any number of observers whether they be company time study engineers or union representatives.

In making time studies, Mundel[1] lists five distinct steps. They are:

1. Defining the standard unit of measurement.
2. Recording the method.
3. Observing the time taken by a particular operator.
4. Rating or relating performance to standard.
5. Application of allowance.

Of these five major steps, it is generally agreed by the foremost leaders in the field of time study that the problem of rating or relating performance to standard is the most difficult. Standard pace is implicitly defined in Mundel's definition of standard time which is:

> The time that will be necessary to accomplish a unit of work, using a given method, under given conditions, by a worker possessing sufficient skill to do the job properly, as physically fit for the job, after adjustment to it, as the average person who can be expected to be put on the job and working at a pace 100/130 of the maximum pace that can be maintained, day after day, without harmful physical effects.[2]

There are many different and varied procedures for the rating of time studies in present day use. Those using purely mathematical formula have usually been discarded as meaningless. Lowry, Maynard, and Stegemerten use a leveling method in which the factors of skill, effort, conditions, and consistency are

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1 Marvin E. Mundel, Systematic Motion and Time Study (New York: Prentice-Hall, Inc., 1947), p. 132.

2 Ibid., p. 131.

determined and then these factors used to enter a performance rating table.[3] However the majority of experts in the field of time study, including Mundel,[4] Presgrave,[5] Barnes,[6] and Carroll,[7] agree that single factor rating seems to be the best, although the basis of the comparison suggested differs from author to author. The definition of rating adopted by the National Committee set up by the Society for the Advancement of Management for the purpose of studying the subject of rating is quoted as follows:

> Rating is that process during which the time study engineer compares the performance of the operator under observation with the observer's own concept of proper performance.[8]

Rating, as frequently employed, requires a great amount of judgment on the part of the time study man inasmuch as he is required to compare the observed rate of activity of an operator against his own mental concept of standard performance.

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3 Steward M. Lowry, Harold B. Maynard, G. J. Stegemerten, Time and Motion Study and Formulas for Wage Incentives (New York: McGraw-Hill Book Company, Inc., 1932), p. 144.

4 Mundel, op. cit., p. 158.

5 Ralph Presgrave, Dynamics of Time Study (2nd edition, New York: McGraw-Hill Book Company, Inc., 1945) p. 154.

6 Ralph M. Barnes, Motion and Time Study (3d edition: New York: John Wiley & Sons, Inc., 1949) p. 352.

7 Phil Carroll, Time Study for Cost Control, (New York: McGraw-Hill Book Company, Inc., 1938) p. 96.

8 Progress Report of the Committee on Rating of Time Studies, Advanced Management, VI (September 1941), 110.

It is obvious that the mental concepts of standard performance will vary between time study raters. It is this intangible mental concept of time study rating that causes unreliable and inconsistent ratings. It has been proposed to attack this problem by the introduction of at least one film of standard pace as a rating aid.[9]

A single standard, single image loop rating aid would allow the rater making the time study to compare visually, at the same instant, the operator's pace against the standard pace as given by the bench mark film. It is suggested that this visual aid of a single standard pace will allow the rater to determine the operator's deviation from that standard pace more accurately and would also increase the consistency of the rating.

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9 Mundel, op. cit., p. 159

It is obvious that the overall coherence of standard performance will vary between time study raters. It is this inconsistency of time study rating that causes unreliable and invalid Testing. It has been proposed to attack this problem by the introduction of at least one film of standard pace as a rating aid.[6]

A simple objective, single image film rating aid would give the rater seeing the time study to conduct himself, at the same instant, the operator's pace against the standard pace as given by the sound work film. It is suggested that this visual aid of a film strip projected once will place the rater to correlate the operator's duration time sheet accurately and more accurately the variation of the performance of the rating.

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[6] Donati, *Op. cit.*, p. 128

PURPOSE

Little, if any, information concerning the use of a single standard, single image loop rating aid is available; hence, the main purposes of this thesis are:

1. Determine the accuracy of the assigned ratings when using this aid.

2. Determine the consistency of the assigned ratings when using this aid.

3. Determine whether or not rating ability when using this aid is affected by:

   a. Experience in the field of time study.

   b. Geographical area in which the observer is employed.

   c. Place of initial time study training.

   d. Number of employees in plant in which the observer is employed.

   e. Size of town in which company is located.

   f. Method of rating.

study, if any, relationship between the use of a single
stopwatch, single timer knob setting and its reliability; namely, the
main purposes of this thesis are:

1. Determine the accuracy of the electronic timing unit
using this aid.

2. Determine the consistency of the electronic timing unit
using this aid.

3. Determine whether or not the time study man using this
aid is affected by:

a. Experience in the field of time study.

b. Psychological area in which the observer
is employed.

c. Place of initial time study training.

d. Number of employees in plant in which
the observer is employed.

e. Size of town in which observer is located.

f. Method of rating.

PROCEDURE: PART A

Before the Collection of the Data

Previous investigations have resulted in evidence which indicates that motion pictures are one of the best methods for making time studies.[10,11] It was found to be as accurate or more accurate and consistent than that of rating the actual operator at the job. One of the same studies[12] also indicates that the entire cycle should be rated, rather than individual elements, to obtain more acourate and consistent results in the ratings. With this in mind, motion pictures of operations were made with a camera running at a constant speed of one thousand feet per minute. The film was then spliced into a loop and, by means of a "strobotac", projected at the same speed at which it was taken. The single image loop aid was made in the same manner and presented an operator working at a pace which was regarded as standard pace.

The films that were rated consisted of six different actual factory operations, each of the operations being performed at three different rates of activity. These ratings thus provided an indication of rating ability over a reasonable range of activity. A careful analysis of the eighteen films

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10 Ralph M. Barnes, "What Has Been Done to Improve Rating Operator Performance", Proceedings of the National Time and Motion Study Clinic, (November 1945) p. 15.

11 Louis Margolin, "A Comparison of Two Methods of Presentation for Time Study Rating," (Unpublished Master's thesis, Purdue University, Lafayette, Indiana, 1948) p. 13

12 Loc. cit.

[illegible]

[illegible] Before the Dollmaking of the Dead

[illegible] Previous investigations have resulted in evidence which indicates that working patterns are one of the best measures for making time studies.[10,11] It was found to be necessary at this juncture and consistent with the logic of testing the actual operator at the job. One of the work studies[12] also indicated that the motion cycle should be tested, before time increment elements, to obtain more accurate and dependable results in the reading. With this in mind, motion pictures of operations were made with a camera running at a constant speed of one second [illegible] One film was taken [illegible] from each, by means of a "storyboard", depicted at the time shown at which it was taken. The static image lock and key was in the view finder and presented an operator working at a [illegible] was centered as closely [illegible]

The films that were taken consisted of six different manual factory operations, each of the operations having performed at three different rates of activity. Three cameras [illegible] that provided an indication of having whilst over a [illegible] image of activity. A control activity of the eighteen films

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10 Ralph E. Barnes, "Work Sat Does Time to Improve Doing Operator Performance", Principles of Job Methods Time and Motion Study Chicago, [illegible] p. 12.

11 Louis Borgolin, "A Comparison of Two Methods of Predetermining for Time Study Rating," Unpublished Master's Thesis, Purdue University, Lafayette, Indiana, 1949) p. 12

12 Ibid. 12.

was made in order to check method and to determine the length of each of the cycles. For cycle times see table 1, Appendix A. The films were carefully edited and spliced into film loops so they could be shown continuously. All the cycles in the same loop were chosen so that they were the same rate of activity.

PROCEDURE: PART B

The Collection of Data

In the evaluation of the single standard single loop aid in rating time studies, a group of seventy-three experienced time study engineers were employed as the raters. The data was obtained during the afternoon session of the Fifth Annual Time and Motion Work Session conducted under the supervision of Dr. Marvin E. Mundel, Professor of Industrial Engineering at Purdue University, on March 15, 1950. The roster of those attending is given in table 2, Appendix A. In order to facilitate the recording and the tabulation of the data, preidentified mark-sensing IBM cards were used to record the observer's assigned ratings. The IBM card code number along with certain other pertinent information was recorded by the time study engineers on a questionnaire which they filled out at the beginning of the work session.[13] The cover page of the questionnaire is reproduced in table 3, Appendix A.

The single image loop rating aid was one of twelve loops rated by the same group in the morning session.[14] From the data obtained in the raw rating of the twelve loops from those raters having over one year's experience, the 100% loop was determined. It was this loop which was used for the standard bench mark in the afternoon single standard, single image loop aid rating session.

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13 Bernard S. Borrus, "The Present State of Time Study," (Unpublished Master's Thesis, Purdue University, Lafayette, Indiana, 1950)

14 Larry S. Lockett, "An Evaluation of Time Study Rating of a Synethic Task," (Unpublished Master's Thesis, Purdue University, Lafayette, Indiana, 1950)

The Objective Test

In the evaluation of the "real" skeleton built into the latest time studies, a group of research-type efficiency study engineers were employed by the firm. The data was obtained during the afternoon session of the fifth annual Time and Motion Work Section conducted under the auspices of Dr. Edwin I. Bowman, Professor of Industrial Engineering at Purdue University, on March 16, 1956. The people of these activities is given in Table A. Appendix A. In order to facilitate the recording and the tabulation of the data, pre-prepared mark-sensing IBM cards were used to record the observer's analyzed tasks. The IBM card deck number along with certain other pertinent information was recorded by the time study engineer on a questionnaire which was filled out at the beginning of the work session.[1] The outer page of the questionnaire is reproduced in Table 7, Appendix A.

The single large loop reading old was in the setting machine.[2] Iron the gate notched in the top rolling of the center tongue form shown faster during over one hour's operations, the LOOK loop was determined. It was this loop motion was used for the standard hourly work in the afternoon session, single large loop old reading machine.

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[1] Edward I. Bowman, "The Process Plant of Time Study," (Unpublished Master's Thesis, Purdue University, Lafayette, Indiana, 1950).

[2] Larry E. Loewen, "An Evaluation of Time Study Method at a Concrete Tank," (Unpublished Master's Thesis, Purdue University, Lafayette, Indiana, 1956).

The films which were rated were shown to the group in the random order, as outlined in table 1, Appendix A. Immediately to the right of the film being rated was projected the single image loop rating aid. Before the actual rating of the film was undertaken, the group was carefully instructed as to the following cautions and methods to be employed in assigning the ratings:

1. The only criterion to be judged was the rate of activity of the body member controlling the speed at which the work was being performed, taking no account of the job difficulty.

2. The rating of each of the eighteen films by the individual observers was to be determined by using the single image loop aid as the bench mark for 100% pace.

3. The methods as presented in the films shown were to be accepted as correct.

4. The films were projected on the screen for approximately three minutes, allowing one minute for the raters to record their ratings on their personal recording sheets and on the IBM cards provided each rater.

DATA

The pertinent information as outlined below was taken from the observer's questionnaires and entered on his marked IBM cards. The cards were then processed through the various IBM machines obtaining twenty-two arrays of the observer's assigned ratings for each of the eighteen films based on the following breakdowns.

A. Entire group as a whole

B. Degree of Experience
   1. 0-6 months
   2. 6 months - 2 years
   3. 2-4 years
   4. over 4 years.

C. Geographical Area of Observer
   1. Northern Midwest (Excluding Michigan)
   2. Central Midwest
   3. Southern Midwest
   4. Michigan

D. Place of Initial Time Study training
   1. College
   2. Company

E. Number of employees in plant
   1. Under 200
   2. 200- 1000
   3. over 1000

[illegible]

The department information be outlined below was taken from the University's curriculums and bulletin of its various job units. This study was then processed through the various job requisites outlining thoroughly entire of the computer's internal machine for each of the eighteen fields listed on the following questionnaire.

A. Entire group as a whole

B. Degree of Importance

1. 0-6 months

2. 6 months - 2 years

3. 3-4 years

4. over 4 years.

C. Correspondence Log of Computer

1. Software Systems (Teaching Experience)

2. Control systems

3. Electronic science

4. Biology

5. Flows of Digital Time Study Training

1. Courses

2. Computer

3. Symbols in mathematics in class

1. Under 300

2. 300- 1000

3. over 1000

F. Population of town in which plant is located

1. Under 5,000
2. 5,000 - 10,000
3. 10,001 - 25,000
4. 25,001 - 50,000
5. 50,001 - 100,000
6. Over 100,000

G. Method of rating

1. By own concept of standard performance
2. By some film or other embodiment of standard performance

With the assumptions that the data was obtained from a group of observers who know how to rate and that there is no way to know the exact correct rating values of the eighteen films, the best approximations of the correct rating values to be assigned to the films were found in the manner as outlined in table 4, Appendix B. A consistent series based on the actual number of film frames for each cycle was obtained for each job. The averages of the observer's ratings on each job were correlated with this consistent series so that the sums of the squares of their deviations from this series were a minimum. A sample calculation of the best approximation of the correct rating values is given in table 5, Appendix B.

"Accuracy" is a measure of how near a given rating is to the best available approximation of the correct rating value,

while "consistency" is a measure of how near a given rating is to the group average.

The observers assigned ratings were compared with the best equivalent correct rating values thus found and the various percentages of observers within the rating error limits of ±5%, ±7½%, ±10%, ±20%, and over ±20% were computed for the entire group and the various group breakdowns. In a similar manner, the observers' ratings were compared with the group average to determine the percentages within the given consistency limits.

In order to determine whether the suspected cause of variation of the mean number of observers within the limits of ±5%, ±7½%, ±10%, and ±20% among the various sub-group breakdowns was real, or if instead the observed variations in means were merely attributable to chance, the statistical technique of analysis of variance was employed.[15] The analysis of variance takes into account the number of means as well as the differences between those means. This is necessary as the difference between a group of means is a function of the number of means available for comparison. See table 6, Appendix B for outline of method.

Those sub-groups which the analysis of variance indicated that there was something else beside chance causing the means to differ significantly among themselves were further investigated by application of the "t distribution" in order to pick out those pairs of means which differed significantly.

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15 Paul G. Hoel, Introduction to Mathematical Statistics (New York: John Wiley & Sons, Inc., 1947), p. 158

while "consistency" is a measure of how near a given result is to the group average.

The observers ranked patches were compared with the computed content testing values thus found and the various percentages of observers within the testing error limits of $\pm 2\frac{1}{2}\%$, $\pm 5\%$, $\pm 10\%$, $\pm 20\%$, and over $\pm 20\%$ were computed for the entire group and the various group breakdowns. In a similar manner, the observers' testing data compared with the group average to determine the percentage within the given consistency limits.

In order to determine whether the suggested cause of variation of the main number of observers within the limits of $\pm 2\frac{1}{2}\%$, $\pm 5\%$, and $\pm 10\%$ among the various sub-group breakdowns was real, or if instead the observed variations in means were merely attributable to chance, the statistical technique of analysis of variance was employed.[13] The analysis of variance tests into account the number of cases as well as the difference between those means. This is necessary as the difference between a pair of means is a function of the number of cases available for comparison. See table 6, appendix B for outline of method.

Those sub-groups which the analysis of variance indicated that there was somewhat else beside chance causing the means to differ significantly among themselves were further investigated by application of the "t distribution" in order to pick out those units of means which differed significantly.

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[13] Paul G. Hoel, Introduction to Mathematical Statistics (New York: John Wiley & Son, Inc., 1947), p. 159

RESULTS

In analyzing the ratings, it was found that of the entire group of seventy-three time study engineers, 33% of their ratings fell within ±5% of the correct rating values, 48% within the ±7½% limits, 58% within the ±10% limits, while 89% were within ±20% of the correct rating values.

A measure of consistency of the same group showed that 38% of the ratings were within ±5% of the group averages, 55% within the ±7½% limits, 64% within ±10% limits, and 84% within ±20% limits. See table 7, Appendix C for entire group analysis.

Statistical tests, employing the analysis of variance, showed that all the variations in accuracy of ratings of sub-groups within the groups based on the factors of degree of experience, geographical area of observer, place of initial time study training, number of employees in the plant, population of the town in which the plant is located, and method of rating, are of no statistical significance and all differences can be attributed to pure chance alone. This was found to be true of the variations in accuracy of those within ±5%, ±7½%, and ±10% of the correct rating value. See table 15, Appendix C for statistical significances of various group breakdowns.

A similar test showed that the variations in consistency, as affecting the numbers of ratings within ±5%, ±7½%, and ±10% of sub-groups based on the factors of degree of experience,

Results

place of initial time study training, number of employees in plant, and method of rating are of no statistical significance.

An analysis of the effect of size of town upon the consistency of the assigned ratings resulted in significance at the 5% level and at the 1% level for those within ±5% and ±10% respectively, of the group means. The six sub-group means of those in the various size of town breakdowns who were within ±7½% of the group means were not found to differ significantly.

The breakdown by geographical area resulted in the greatest statistical significance of the entire analysis. In the consistency of the ratings within ±5% of the group means, significance was found at the 1% level. The critical value of F was 4.08, while the computed value of F_c was 5.33. Also significance was found at the 5% level for consistency of rating within ±7½% and ±10% of the group means. The ratings of the Michigan group of nine men were the cause of this significant difference. The consistency of the assigned ratings by the Michigan group of raters was much higher than that of the Northern, Central, and Southern-Midwest groups; however, the Michigan group consisted of only nine raters.

CONCLUSIONS

The interpretation of the results must be made in the light of the following limitations:

1. The observers did not have first hand familiarity with the tasks involved.

2. A film presentation to some observers was a new means of rating.

3. The observers, contrary to instructions, may have based their judgement on something other than the rate of activity of the body member controlling the speed at which the work was being performed.

4. The seating location may have enabled some to see the screen more clearly than others.

5. There was no way to effectively check possible collusion between those observers seated near each other.

6. The fatigue of the raters.

From an appraisal of the data and within the limitations as given above, several conclusions concerning the rating ability of the group of industrial engineers under study may be made. The conclusions are:

1. Time study engineers have a tendency to rate the slower paces too high, and the higher paces too low, even when using a single-image rating aid.

2. The accuracy of the ratings assigned by observers using the single standard, single-image loop aid does not correlate with any degree of experience. Those raters with little or no experience are equally accurate in assigning

rating values as those raters who have had several years experience in the field of time study. The consistency of the ratings, like accuracy, does not depend upon any degree of experience. The raters with merely "over six months experience" are just as consistent in their ratings as those with "four or more years of experience."

3. The place of initial time study training whether it be in a college or in an industrial organization has no effect on the accuracy and consistency of time studies when using the single loop aid. The company trained men can rate just as well as the college trained men, and vice versa.

4. The number of employees in the plant in which the time study engineer is employed has no effect on the assigned ratings. Those engineers from plants employing a small number of personnel have about the same accuracy and consistency, when using this aid, as engineers from large industrial organizations.

5. The method of rating has no correlation with either the accuracy or the consistency of the ratings assigned when using the single loop aid. Those rating by some film or other embodiment of standard performance and those rating by their own concept have the same degree of accuracy and consistency. Thus the single loop aid tends to eliminate differences caused by differences in concepts of standard performance by providing a single concrete standard that is the same for any number of observers.

6. The size of town in which the company is located does not reflect in any way on the accuracy of time study ratings when using the single image loop aid. The analysis of the consistency of the ratings within ±5% of the group mean of this group, however, indicated that they were barely significant. This is not considered to be conclusive evidence and this result indicates than an explanation other than size of town variation should be sought to account for this variability. A possible explanation for this barely significant difference can be attributed to the fact that the analysis of the data was made only on the basis of one parameter and also the number of raters in the six sub-groups varies from 7 to 18, thus a few non-consistent ratings by one or more members of the smaller groups would tend to have more effect on the group mean than would similar ratings have in the larger groups. It is felt that due to the above reasons, no conclusions on the effect of the size of town on the consistency of ratings are deducible. It is suggested that further investigations should be made using two or more parameters in order to substantiate or reject this hypothesis.

7. The Michigan group did significantly better than other geographical groups in consistency of rating when using the single image loop aid, however, all geographical areas were equally accurate in their ratings. The Michigan group of nine raters were mainly from the same town. A

possible explanation as to why the Michigan group exceeded the others in consistency is that all of the group (from all towns) were previously familiarized with the use of the single loop aid by Dr. Mundel while he was either acting in a consultant capacity to their company or working with one at their professional group.

8. The use of the single standard, single image rating aid resulted in 33% of the raters being within ±5% of the best estimate of the correct rating values and 39% of the group being within ±5% of the group average. Even though the single image loop aid was entirely new to the majority of the men attending the work session they were able to rate as consistently and accurately using this new technique as they were able to rate using their own individual techniques. A well recognized psychological characteristic of learning is that when a person has previously been taught one method of doing a task, he usually has more difficulty in learning a new method and his performance is usually lowered when he first adopts the new method.[16] This suggests that with practice, the accuracy and consistency of the ratings using the single loop aid will surpass those obtained by the conventional methods.

Precision can be greatly enhanced by group rating and group training in the art of rating and the single loop aid

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16 Joseph Tiffin, Industrial Psychology, (New York: Prentice Hall, Inc., 1947), p. 295.

closed training in the art of testing and the simple loop aid function can be greatly enhanced by closed testing and additional methods.

The simple loop aid will express those obtained by the conventional methods. The accuracy and consistency of the testing method, the accuracy and consistency of the testing using the simple loop aid will express those obtained by the conventional methods.

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16 Joseph Tiffin, Industrial Psychology, (New York: Prentice Hall, Inc., 1947), p. 288.

may afford us a means to accomplish this. It should also be noted that the single loop aid also eliminates the different conceptions of standard performance and starts training the rater in judgement with a concrete and specific definition of standard performance.

APPENDIX A

TABLE 1

CYCLE TIME AND ORDER OF PRESENTATION OF FILMS

FILM NUMBER	ORDER OF FILM PRESENTATION	CYCLE TIME
1-1	3	.254
1-2	16	.250
1-3	18	.216
2-1	5	.624
2-2	15	.497
2-3	7	.377
3-1	12	.147
3-2	2	.131
3-3	10	.114
4-1	8	.221
4-2	11	.205
4-3	4	.160
5-1	14	.146
5-2	13	.132
5-3	6	.139
6-1	1	.307
6-2	9	.296
6-3	17	.296

TABLE I

TRUE TIME AND ORDER OF IDENTIFICATION OF TIME

TIME INTERVAL	ORDER OF TIME IDENTIFICATION	TRUE TIME
A-1	9	.134
A-2	15	.220
A-3	18	.316
B-1	5	.084
B-2	12	.207
B-3	4	.077
B-4	10	.147
C-1	6	.121
C-2	16	.214
C-3	8	.091
D-1	11	.145
D-2	3	.068
D-3	14	.162
E-1	13	.158
E-2	2	.062
E-3	1	.047
F-1	7	.098
F-2	17	.256

TABLE 3

ROSTER OF THOSE ATTENDING

MOTION AND TIME STUDY WORK SESSION

MARCH 15, 1950

Abbett, R. E., Noblitt-Sparks Industries, Inc., North Plant, Seymour, Indiana.
Arendes, Harold W., American Steel Foundries, East St. Louis, Illinois.
Bauman, Robert F., Pitman-Moore Co., Indianapolis, Indiana.
Benson, Lester S., Brunswick Balke Collender Co., Muskegon, Michigan.
Blackall, Lowell, Corduroy Rubber Company, Grand Rapids, Michigan.
Bluhm, Charles F., Noblitt-Sparks Industries, Inc., Columbus, Indiana.
Border, Chelsea W., Crosley Corporation, Richmond, Indiana.
Brose, H. W., American Steel Foundries, Hammond, Indiana.
Burt, Gerald W., Corduroy Rubber Company, Grand Rapids, Michigan.
Clark, Kenneth, Stephen A. Young Corp., Flora, Indiana.
Coleman, Charles F., Timken Detroit Axle Co., 100-500 Clark St., Detroit, Michigan.
Coleman, Gene, Cummins Engine Co., Columbus, Indiana.
Collins, Thomas E., National Malleable & Steel Castings Co., 546 North Holmes Avenue, Indianapolis, Indiana.
Crum, Paul C., Perfect Circle Corp., Hagerstown, Indiana.
Culbertson, Morris E., National Malleable & Steel Castings Co., Indianapolis 6, Indiana.
Donald, G. C., Aluminum Company of America, Lafayette, Indiana.
Duntley, John M., Colgate-Palmolive-Peet Co., Jeffersonville, Indiana.
Eagle, William K., Burson Knitting Co., Rockford, Illinois.
Ertel, Mark A., Perfect Circle Corp., Tipton, Indiana.
Ferguson, Walter, General Tire & Rubber Co., Logansport, Indiana.
Ford, G. Robert, Johns-Manville Corp., Alexandria, Indiana.
Gossman, Carl, Cummins Engine Co., Columbus, Indiana.
Hanson, Floyd K., Sealed Power Co., Muskegon, Michigan.
Hubbman, Harold, Cummins Engine Co., Columbus, Indiana.
Hunter, Benton, David Bradley Mfg. Co., Bradley, Illinois.
Imhoff, J. L., University of Minnesota, Minneapolis, Minnesota.
Jackson, Morris M., Duncan Electric Mfg. Co., Lafayette, Indiana.
Johnson, Ray, Perfect Circle Corp., Hagerstown, Indiana.
Jones, John C., Johns-Manville Corp., Alexandria, Indiana.

TABLE 2

BOARDS OF TRADE affiliated

[illegible] 12, 1950

TABLE 2

Keller, Donald W., Noblitt-Sparks Industries, Inc., Columbus, Indiana.
King, E. L., Brunswick Balke Collender Co., Muskegon, Michigan.
Keepman, W. J., Aluminum Company of America, Lafayette, Indiana.
Laitala, Everett, University of Illinois, Urbana, Illinois.
Leman, Howard H., Armstrong Cork Co., Kankakee, Illinois.
Lewis, Richard L., Johns-Manville Corp., 920 West Washington St., Alexandria, Indiana.
Long, Paul R., Cummins Engine Co., Columbus, Indiana.
Luther, F. H., Muskegon Piston Ring Co., Muskegon, Michigan.
Marek, Robert F., Colgate-Palmolive-Peet Co., Jeffersonville, Indiana.
Martin, Duane, General Tire & Rubber Co., Wabash, Indiana.
McAlpin, Melburn, W., Dobbins Mfg. Co., 702 W. Beardsley Ave., Elkhart, Indiana.
McMillan, Robert H., Noblitt-Sparks Industries, Inc., Franklin, Indiana.
Miller, Larry, RCA-Victor Division, Indianapolis, Indiana.
Morgan, William H., Colgate-Palmolive-Peet Co., Jeffersonville, Indiana.
Morris, Ned F., Colgate-Palmolive-Peet Co., Jeffersonville, Indiana.
Myers, Gordon, General Tire & Rubber Co., Logansport, Indiana.
Napier, Gerald E., Colgate-Palmolive-Peet Co., Jeffersonville, Indiana.
Neese, John F., Noblitt-Sparks Industries, Inc., Greenwood, Indiana.
Nickelson, Robert L., Crosley Corporation, Richmond, Indiana.
Patterson, Kenneth, Noblitt-Sparks Industries, Inc., Columbus, Indiana.
Pickering, John E., Johns-Manville Products Corp., 920 W. Washington, Alexandria, Indiana.
Pickett, Milton, Noblitt-Sparks Industries, Inc., North Vernon, Indiana.
Poer, Lowell S., General Tire & Rubber Co., Wabash, Indiana.
Rahdert, Karl G., Indiana University, Bloomington, Indiana.
Ruble, James K., Noblitt-Sparks Industries, Inc., Columbus, Indiana.
Sands, Oran J., Jr., Noblitt-Sparks Industries, Inc., Columbus, Indiana.
Schroeder, Roy C., Peerless Pumps Co., Indianapolis, Indiana.
Seelge, Robert G., David Bradley Mfg. Works, Bradley, Illinois.
Sefing, Nicholas R., Brunswick Balke Collender Co., Muskegon, Michigan.
Simerson, Floyd W., David Bradley Mfg. Works, Bradley, Illinois.
Skaggs, E., Timken Detroit Axle Co., Kenton, Ohio.

TABLE 2

Slater, Keith, Evansville College, Evansville, Indiana.
Smith, Harold A., RCA-Victor Division, Indianapolis, Indiana.
Sorenson, Richard J., Colgate-Palmolive-Peete Co., Jeffersonville, Indiana.
Straus, Herman A., Servel Inc., Evansville, Indiana.
Swindell, John M., Perfect Circle Corp., Hagerstown, Ind.
Tilles, Seymour, Timken Detroit Axle Co., 100-400 Clark Ave., Detroit, Michigan.
Trout, Gordon M., Peerless Pump Div., Indianapolis, Indiana.
Weber, Ray, Perfect Circle Corp., Hagerstown, Indiana.
Welborn, Charles B., Johns-Manville Corp., Alexandria, Indiana.
Wild, W. R., American Steel Foundries, East Chicago, Indiana.
Worl, Gene D., Perfect Circle Corp., Box 191, New Castle, Indiana.
Young, Stephen A., Sayco Fixture Fashions, Flora, Indiana.

TABLE 6

TABLE 3

TIME STUDY WORK SESSION QUESTIONAIRE

BE SURE TO COPY THE FIRST THREE DIGITS OF YOUR CARD DECK NUMBER IN THE SPACE PROVIDED. Please answer all questions as accurately as possible. Circle number to left of appropriate answer. All of the information on this questionaire is considered CONFIDENTIAL. Neither your name nor the company name will be revealed in any way.

1. ____ 2. ____ 3. ____

A. Name_____

B. Company_____

4. Mailing Address_____

5. What characterizes the direct labor in your plant:
   1. Bench work
   2. Machine work
   3. Gross body movements (moving around)
   4. Equal amounts of all three named above.

6. Number of employees in your plant.
   1. 50 or less
   2. 51 to 100
   3. 101 to 200
   4. 201 to 300
   5. 301 to 500
   6. 501 to 750
   7. 751 to 1000
   8. 1001 to 1500
   9. Over 1500

7. Length of time you have been making time studies.
   1. Less than six months and actively engaged
   2. Less than six months, but not now actively engaged
   3. More than six months, but less than a year and actively engaged
   4. More than six months, but less than a year and not now actively engaged
   5. More than one year, but less than two years and actively engaged
   6. More than one year, but less than two years and not now actively engaged
   7. Two to four years
   8. Five to ten years
   9. Over ten years

Table 3

Size query form showing coordinating

By means of card for first year
display of first card for second by use
column position. Please answer all
questions as accurately as possible.
Circle numbers to left of appropriate
answer. All of the information on
this questionnaire is confidential
CONSTRUCTION. Matching plus blanks may
the computer mode will be retained in
any way.

	1.	2.	3.
A. Name			
B. Company			
4. Mailing address			

5. What characteristics are direct labor is your plant?
   1. Union work
   2. Mobile work
   3. Close body movement (moving around)
   4. Equal amounts of all three listed above.

6. Number of employees in your plant.
   1. 25 or less
   2. 26 to 100
   3. 101 to 200
   4. 201 to 300
   5. 301 to 500
   6. 501 to 750
   7. 751 to 1000
   8. 1001 to 5000
   9. over 5001

7. Length of time you have been making items related.
   1. Less than six months, but now actively engaged
   2. More than six months, but less than a year and actively engaged
   3. More than one year, but less than two years and actively engaged
   4. More than two years, but less than five years and actively engaged
   5. Five to ten years
   6. Over ten years

TABLE 3

8. Where did you receive your initial time study training? Give name and location.
   1. College_____
   2. Extension_____
   3. Company_____
   4. Other_____

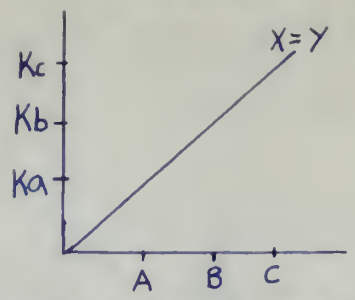
9. Do you rate compared to
   1. your concept of standard performance
   2. some film or other embodiment of standard performance

TABLE 6

APPENDIX B

TABLE 4

DERVIATION OF K



Problem: To determine the value of K so that the sum of the squares of the variation about the X Y line is a minimum.

Let: 1. A, B, and C be the average of the ratings assigned by the observers on the three paces of the same job.

2. a, b, and c be a consistent series based upon the frame count of the three paces on the same job determined as follows:

N_1 is the frame count per cycle of first film
N_2 is the frame count per cycle of second film
N_3 is the frame count per cycle of third film

then, $a=\frac{N_2}{N_1}$ $b=\frac{N_2}{N_2}$ $c=\frac{N_2}{N_3}$

The sum of the deviations about X=Y is,

$$d = A-Ka+B-Kb+C-Kc$$

Squaring the sum of these deviations

$$d^2=(A-Ka)^2 + (B-Kb)^2 + (C-Kc)^2$$
$$= A^2-2AKa+K^2a^2+B^2-2BKb+K^2b^2+C^2-2CKc+K^2c^2$$

Now in order to find a minimum value of K, we take the first partial deviative of d^2 with respect to K and set it equal to zero.

$$\frac{\delta d^2}{\delta K} = 2(-Aa+Ka^2-2Bb+Kb^2-Cc+Kc^2) = 0$$

Solving for K,

$$K = \frac{Aa+Bb+Cc}{a^2+b^2+c^2}$$

TABLE 4

DEFINITION OF E

Problem: To determine the value of E as that the sum of the squares of the variation about the E I line is a minimum.

Let: 1. A, B, and C be the average of the ratings assigned by the observers at the three places of the same job.

2. b_1, B_1, and c be a corresponding series taken upon the items count of the first pass on the same job previously as follows:

b_1 is the items count per cycle of first file
B_1 is the items count per cycle of second file
c_1 is the items count per cycle of third file

then, $a=\frac{b_1}{c_1}$ $b=\frac{B_1}{c_1}$ $c=\frac{c_1}{c_1}$

The sum of the deviations about I=I K,

$$d = k-Ek+B-EB+C-Ec$$

Squaring the sum of these deviations

$$d^2=[k-Ek]^2 + [B-EB]^2 + (C-Ec)^2$$

$$=k^2-2kEk+E^2k^2+B^2-2BEB+E^2B^2+C^2-2CEc+E^2c^2$$

Now it is easy to find a minimum value of d^2, as take the first partial derivative of d^2 with respect to E and set it equal to zero.

$$\frac{\partial d^2}{\partial E} = 4k-2k+2E^2k^2-2BB+2E^2B^2-2Cc+2E^2c^2 = 0$$

Solving for E,

$$E=\frac{k^2+B^2+c^2}{k^2+B^2+C^2}$$

TABLE 5

Film No.	IBM Column	Group Identification	Sum of Ratings
1. 1-1	1. 7-9 (4)		1. 7012 (72)
2. 1-2	2.19-21 (5)	TOTAL GROUP	2. 7693 (72)
3. 1-3	3.25-27 (5)		3. 7865 (72)

Consistent Series		Average of Ratings	Product		
a	.984	A 97.5	95.9		Ka 97.8
b	1.000	B 106.8	106.8	K .9948	Kb 99.5
c	1.157	C 109.2	126.3		Kc 115.1

$a^2+b^2+c^2 = 3.307$ $Aa+Bb+Cc = 329.0$

Data to Determine % Within Various Rating Errors

Actual Rating	No.in ±5%	No.in ±7½%	No.in ±10%	No.in ±20%	% in ±5%	% in ±7½%	% in ±10%	% in ±20%
Ka 98	35	44	51	67	49	61	71	93
Kb 100	34	36	52	67	47	50	72	93
Kc 115	36	40	48	69	50	56	67	96

Data to Determine % Rating Within Various %'s of Group Mean

Mean								
A 98	35	44	51	67	49	61	71	93
B 107	33	50	55	70	46	70	76	97
C 109	20	35	64	70	28	49	49	97

SAMPLE DATA SHEET FOR CALCULATION OF BEST APPROXIMATIONS OF CORRECT RATING VALUES AND ACCURACY AND CONSISTENCY PERCENTAGES

Table 5

Title No.	Item Options	Corpus Christi Hotels	Type of Mailing
1. 1-1	1. 7-3 (4)		1. 7013 (73)
2. 1-3	2. 12-21 (6)	TOTAL CHOICE	2. 7603 (72)
3. 1-5	3. 23-39 (5)		3. 7804 (73)

- - - -

TABLE 6

METHOD OF ANALYSIS OF VARIANCE AS APPLIED TO THE DIFFERENCE AMONG SEVERAL MEANS

Q = Total variation
Q_c = Variation among the column means
Q_e = Total variation within the columns
T = Grand total of all x's in table
N = Number of x's in table
T_1 = Total of all x's in first column
T_2 = Total of all x's in second column
k = Number of groups
N_1 = Number of x's in the first column
N_2 = Number of x's in the second column
$\hat{\delta}_c^2$ = Unbiased estimate of variance of column means
$\hat{\delta}_e^2$ = Unbiased estimate of variance within columns

$$Q = (\text{Sum of squares of individual x's}) - \frac{T^2}{N}$$

$$Q_c = \left(\frac{T_1^2}{N_1} + \frac{T_2^2}{N_2} + \ldots\ldots + \frac{T_k^2}{N_k}\right) - \frac{T^2}{N}$$

$$Q_e = Q - Q_c$$

$$\hat{\delta}_c^2 = \frac{Q_c}{k - 1} \qquad \hat{\delta}_e^2 = \frac{Q_e}{N - k}$$

$$F_c = \frac{\hat{\delta}_c^2}{\hat{\delta}_e^2}$$

To determine whether the F_c is significant, look up the levels of 1% and 5% in the F tables for degrees of freedom $k - 1$, and $N - k$.

If the F_c from the data exceeds $F_{.01}$ then there is good evidence that there is something else besides chance causing the columns to differ significantly among themselves.

If the observed F_c lies between $F_{.01}$ and $F_{.05}$ we do not have conclusive evidence but in some cases would be willing to assert that there is an assignable cause at work.

If the observed F_c is below $F_{.05}$ we have no real evidence for supposing that anything besides chance is responsible for

TABLE 8

SCORES ON EXERCISE OF RELATIVE TO EVALUATION OF THE

DIFFERENCE AMONG SCHOOLS GIVEN

the observed variation from one column mean to another.

the observed variation from one column among is nothing.

APPENDIX C

TABLE 7

ENTIRE GROUP (72 Men)

ACCURACY

FILM NO.	BEST APPROX. CORRECT RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	98	49	61	71	93
1-2	100	47	50	72	93
1-3	115	50	56	67	96
2-1	85	8	31	32	74
2-2	107	29	53	57	94
2-3	141	32	50	51	93
3-1	75	7	16	17	50
3-2	85	18	46	46	93
3-3	97	11	31	33	74
4-1	97	21	26	49	71
4-2	105	71	72	86	97
4-3	134	25	43	44	93
5-1	106	31	60	74	93
5-2	117	38	51	74	99
5-3	111	54	61	89	99
6-1	96	32	47	64	92
6-2	104	29	46	53	97
6-3	104	39	62	68	97
	AVERAGE	33	48	58	89

CONSISTENCY

FILM NO.	GROUP AVERAGE RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	98	49	61	71	93
1-2	107	46	69	76	97
1-3	109	28	49	49	97
2-1	95	51	53	68	86
2-2	108	28	53	57	94
2-3	134	36	47	53	92
3-1	90	32	50	51	89
3-2	84	29	46	46	85
3-3	86	39	51	51	82
4-1	108	19	47	50	97
4-2	105	71	72	86	97
4-3	125	49	51	58	97
5-1	108	31	68	68	97
5-2	111	39	44	70	97
5-3	109	42	58	87	99
6-1	97	32	47	64	92
6-2	108	28	67	68	99
6-3	105	58	62	78	97
	AVERAGE	39	55	64	94

TABLE 3

(See text)

ACCURACY

Item No.	Correct Value	%	%	%	%
1-1	99	98	81	71	87
1-2	100	47	80	79	83
1-3	119	39	89	87	86
2-1	95	8	75	75	74
2-2	107	80	82	87	84
2-3	111	88	80	81	88
3-1	75	7	71	77	80
3-2	85	78	46	88	93
3-3	87	77	93	92	74
4-1	87	87	80	85	73
4-2	100	73	84	86	87
4-3	104	78	82	84	82
5-1	108	91	80	74	87
5-2	117	78	91	74	78
5-3	114	84	87	88	83
6-1	96	78	87	84	89
6-2	104	98	87	87	87
6-3	104	78	87	87	87
Average		80	80	79	81

CONSISTENCY

Item No.	Attempt Made	%	%	%	%
1-1	98	78	81	71	82
1-2	104	86	86	76	87
1-3	108	78	49	80	87
2-1	98	81	82	87	84
2-2	108	78	83	87	84
2-3	124	78	87	89	79
3-1	80	72	80	81	88
3-2	84	78	86	84	78
3-3	86	78	81	84	86
4-1	108	72	82	80	87
4-2	108	73	83	88	84
4-3	128	78	82	88	87
5-1	108	72	88	80	87
5-2	117	78	84	78	87
5-3	110	78	82	87	78
6-1	84	83	87	84	83
6-2	108	78	87	88	84
6-3	108	78	82	78	82
Average		78	82	82	84

TABLE 8-A

EXPERIENCE IN TIME STUDY FIELD - 0 to 6 Months (6 Men)

ACCURACY

FILM NO.	BEST APPROX. CORRECT RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	96	67	67	67	83
1-2	97	67	67	83	100
1-3	112	50	50	50	100
2-1	79	0	17	17	67
2-2	100	67	67	83	100
2-3	132	0	33	66	83
3-1	66	0	0	0	17
3-2	74	17	17	17	33
3-3	86	33	33	33	83
4-1	90	17	17	17	83
4-2	97	83	83	83	83
4-3	124	67	67	83	100
5-1	99	50	50	67	83
5-2	109	33	67	83	100
5-3	104	33	67	67	83
6-1	96	50	67	67	83
6-2	99	33	50	67	83
6-3	99	17	33	67	83
	AVERAGE	38	47	56	81

CONSISTENCY

FILM NO.	GROUP AVERAGE RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	87	17	17	17	83
1-2	103	83	100	100	100
1-3	104	50	100	100	100
2-1	86	33	33	66	83
2-2	102	50	67	67	100
2-3	131	0	33	67	100
3-1	80	0	17	17	67
3-2	76	0	17	17	33
3-3	73	33	33	33	50
4-1	103	67	83	83	100
4-2	95	67	83	83	83
4-3	117	83	100	100	100
5-1	108	33	83	83	100
5-2	110	33	33	67	100
5-3	95	33	50	50	83
6-1	86	17	17	33	50
6-2	105	17	17	67	83
6-3	104	67	67	67	100
	AVERAGE	38	55	62	84

TABLE 6-4

ESTIMATION OF TIME SPENT DOING Q IN 6 SECONDS (6 sec)

AVERAGE

PERCENT OF GROUP ATTACK

ITEM NO.	PERCENT CASE	±5%	±2.5%	±10%	±20%
1-1	98	97	97	97	99
1-2	97	97	97	97	100
1-3	173	80	90	90	100
2-1	98	0	17	17	17
2-2	100	97	97	97	100
2-3	100	0	33	99	99
3-1	98	0	0	0	17
3-2	94	17	17	17	33
3-3	89	92	92	92	93
4-1	90	17	17	17	38
4-2	97	95	95	95	98
4-3	134	97	97	95	100
5-1	99	90	90	97	99
5-2	109	99	89	98	100
5-3	101	93	97	97	99
6-1	98	90	97	98	98
6-2	91	93	90	98	98
6-3	99	47	50	97	98
AVERAGE		98	47	98	99

TARGET ISOLATE

PERCENT OF GROUP ATTACK

ITEM NO.	ATTACKED CASE	±5%	±2.5%	±10%	±20%
1-2	84	17	17	17	84
1-3	109	85	100	100	100
1-3	104	80	100	100	100
2-1	98	83	83	83	83
2-2	100	80	83	83	100
2-3	100	0	33	83	83
3-1	80	0	17	17	17
3-2	98	0	17	17	33
3-3	79	92	92	98	98
4-1	109	81	98	98	100
4-2	84	97	98	98	98
4-3	117	89	100	100	100
5-1	106	83	83	89	100
5-2	110	75	92	97	100
5-3	95	92	92	98	98
6-1	88	19	19	33	80
6-2	106	14	14	84	84
6-3	104	84	84	84	100
AVERAGE		78	86	93	94

TABLE 8-B

EXPERIENCE IN TIME STUDY FIELD - 6 Months to 2 Years (16 Men)

ACCURACY

FILM NO.	BEST APPROX. CORRECT RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	98	44	62	75	94
1-2	100	38	44	56	94
1-3	115	44	44	50	100
2-1	84	12	38	38	75
2-2	105	44	44	69	100
2-3	138	19	38	56	94
3-1	78	19	19	19	56
3-2	88	31	50	69	94
3-3	101	25	25	31	62
4-1	97	25	31	50	75
4-2	105	69	75	81	100
4-3	134	31	50	50	94
5-1	110	31	37	69	94
5-2	112	25	75	75	94
5-3	106	44	68	69	100
6-1	101	19	25	56	88
6-2	105	62	69	81	100
6-3	105	69	75	81	100
	AVERAGE	36	48	60	90

CONSISTENCY

FILM NO.	GROUP AVERAGE RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	100	62	69	81	94
1-2	107	44	69	75	94
1-3	107	19	81	94	100
2-1	92	25	44	62	88
2-2	106	31	44	75	100
2-3	132	50	50	75	88
3-1	92	44	44	56	88
3-2	88	31	50	69	94
3-3	89	25	25	44	75
4-1	108	25	56	62	100
4-2	107	56	88	88	100
4-3	133	31	50	50	100
5-1	105	56	62	75	94
5-2	107	44	69	69	94
5-3	107	44	81	81	100
6-1	99	12	25	38	94
6-2	109	31	56	94	100
6-3	104	44	81	81	100
	AVERAGE	38	58	70	94

COMPARISON OF TIME STUDY [1-3 - P Months to P Years (10 Men)]

AGGRESSIVE

FILE NO.	WEST (P/SEC) CONSECUTIVE RATE	±SE	±7.5%	±10%	±15%
1-1	90	14	82	78	94
1-2	120	30	44	86	94
1-3	118	44	84	80	100
2-1	84	18	68	74	78
2-2	108	44	64	82	100
2-3	132	18	86	84	94
3-1	92	18	42	18	88
3-2	88	82	80	88	84
3-3	102	18	88	74	82
4-1	82	20	74	80	92
4-2	108	28	76	82	120
4-3	134	32	80	80	94
5-1	110	32	82	88	94
5-2	114	18	78	72	94
5-3	108	44	88	80	120
6-1	102	18	80	86	88
6-2	106	84	82	84	120
6-3	108	88	78	82	120
AVERAGE	16	48	80	80	80

COMPLETELY

FILE NO.	CHECK ATTENDANCE RATE	±SE	±7.5%	±10%	±15%
1-1	100	42	80	82	84
1-2	104	14	88	78	84
1-3	102	18	82	84	100
2-1	98	28	44	88	88
2-2	108	24	44	78	100
2-3	122	30	80	92	88
3-1	92	44	88	88	88
3-2	88	24	70	88	84
3-3	98	26	84	84	78
4-1	108	28	82	82	100
4-2	102	28	88	84	100
4-3	102	24	80	80	100
5-1	104	24	82	78	84
5-2	102	44	88	88	84
5-3	102	44	84	84	100
6-1	98	12	78	88	84
6-2	106	24	84	84	100
6-3	104	44	82	84	120
AVERAGE	12	58	80	84	84

TABLE 8-C

EXPERIENCE IN TIME STUDY FIELD - 2 to 4 Years (20 Men)

ACCURACY

FILM NO.	BEST APPROX. CORRECT RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	98	45	55	70	95
1-2	108	45	50	65	100
1-3	115	45	45	60	90
2-1	86	30	40	50	80
2-2	108	30	55	60	95
2-3	143	30	35	50	85
3-1	100	20	20	30	55
3-2	87	25	30	65	90
3-3	100	15	15	45	80
4-1	99	20	50	50	65
4-2	107	55	90	90	100
4-3	136	15	20	70	90
5-1	104	50	60	60	95
5-2	116	45	45	60	95
5-3	110	65	65	95	100
6-1	98	45	55	70	85
6-2	102	30	50	55	100
6-3	102	30	55	65	95
	AVERAGE	36	46	62	88

CONSISTENCY

FILM NO.	GROUP AVERAGE RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	97	45	60	70	95
1-2	108	45	60	65	100
1-3	109	30	45	85	90
2-1	96	35	55	65	85
2-2	110	35	35	70	95
2-3	136	35	40	60	85
3-1	91	40	50	65	100
3-2	85	10	30	30	80
3-3	90	50	50	50	80
4-1	111	45	45	90	100
4-2	107	55	90	90	100
4-3	127	45	65	65	95
5-1	107	20	75	75	95
5-2	112	35	60	60	95
5-3	110	65	65	95	100
6-1	94	25	60	60	90
6-2	105	40	50	25	100
6-3	104	30	55	65	95
	AVERAGE	38	55	66	93

TABLE 6-8

ACCURACY

File No.	Density data	±ρd	±2.5%	±10%	±20%
1-1	98	85	65	70	95
1-2	100	75	60	80	100
1-3	110	65	45	85	80
2-1	95	70	40	80	90
2-2	108	80	55	90	95
2-3	102	90	75	80	85
3-1	100	80	80	85	65
3-2	97	85	65	85	80
3-3	100	75	45	60	90
4-1	99	70	60	80	100
4-2	107	75	60	70	100
4-3	104	80	80	90	90
5-1	104	90	80	80	95
5-2	110	65	40	80	100
5-3	112	85	65	90	95
6-1	94	80	30	80	90
6-2	108	90	80	90	100
6-3	104	95	85	80	90
Average		79	64	78	91

CONSISTENCY

File No.	Density data	±ρd	±2.5%	±10%	±20%
1-1	97	90	80	70	95
1-2	109	95	90	95	100
1-3	107	100	90	90	90
2-1	98	75	80	95	85
2-2	110	75	45	70	90
2-3	100	95	90	80	85
3-1	94	80	80	90	100
3-2	110	90	70	80	90
3-3	97	85	80	90	90
4-1	111	85	80	90	100
4-2	107	95	90	90	100
4-3	107	90	85	80	95
5-1	110	95	90	80	95
5-2	114	95	80	80	95
5-3	112	90	85	80	100
6-1	94	80	80	90	90
6-2	108	90	80	90	100
6-3	104	95	85	80	90
Average		89	84	85	94

TABLE 8-D

EXPERIENCE IN TIME STUDY FIELD - Over 4 Years (28 Men)

ACCURACY

FILM NO.	BEST APPROX. CORRECT RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	99	54	64	71	93
1-2	100	39	32	64	96
1-3	116	57	75	79	96
2-1	86	11	18	25	60
2-2	108	31	46	50	96
2-3	142	39	43	57	96
3-1	74	7	14	14	35
3-2	83	40	43	64	89
3-3	96	4	14	21	68
4-1	96	31	25	46	68
4-2	104	46	64	68	96
4-3	133	29	46	64	93
5-1	106	36	54	68	94
5-2	117	43	57	82	100
5-3	112	50	75	79	100
6-1	103	46	61	61	100
6-2	107	32	64	64	96
6-3	107	29	68	79	96
	AVERAGE	33	48	59	87

CONSISTENCY

FILM NO.	GROUP AVERAGE RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	98	54	54	71	93
1-2	107	46	71	79	96
1-3	111	72	75	86	100
2-1	99	36	46	54	86
2-2	109	25	43	64	96
2-3	134	39	50	57	89
3-1	91	54	57	64	89
3-2	83	39	43	64	89
3-3	83	39	43	64	82
4-1	106	32	50	57	89
4-2	104	46	64	67	96
4-3	126	21	50	54	89
5-1	111	39	39	79	100
5-2	113	32	79	86	100
5-3	112	50	75	79	100
6-1	100	54	54	79	96
6-2	111	54	54	86	96
6-3	107	39	68	79	96
	AVERAGE	42	56	70	94

TABLE I-B

EXPERIENCE IN TIME SERVICE FIELD - Grad + Years [BS Econ]

AGGREGATE

Item No.	Decision Date	Sec	Base (Const. $)	Index	Adj
I-1	00	34	94	72	82
I-2	100	30	84	74	84
I-3	173	17	78	78	94
I-4	33	14	74	82	80
I-5	105	14	67	80	96
I-6	100	26	65	87	86
I-7	74	7	74	71	74
I-8	103	10	64	84	84
I-9	00	4	74	81	82
I-10	00	11	85	81	80
I-11	106	00	84	85	88
I-12	133	08	74	84	92
I-13	108	26	74	84	94
I-14	117	40	87	83	80
I-15	113	30	75	77	106
I-16	103	40	84	81	100
I-17	107	33	84	84	84
I-18	107	30	78	73	88
Average		24	80	78	87

CONSTRUCTION

PUBLICITY OF DEVICE SYSTEM

Item No.	Existing Date	Sec	Base ($)	Index	Adj
I-1	94	04	84	71	81
I-2	107	03	71	73	74
I-3	111	73	75	80	100
I-4	0-	03	68	84	87
I-5	100	02	70	84	78
I-6	104	02	70	84	78
I-7	81	04	67	80	83
I-8	85	03	80	84	85
I-9	00	03	70	84	83
I-10	100	03	70	87	80
I-11	106	00	84	87	80
I-12	130	01	84	84	88
I-13	111	02	78	80	100
I-14	112	02	78	80	100
I-15	100	04	74	84	84
I-16	111	04	74	88	84
I-17	107	03	78	73	88
Average		04	75	79	84

TABLE 9-A

AREA - NORTHERN MIDWEST (Ex. MICHIGAN) 20 Men

ACCURACY

FILM NO.	BEST APPROX. CORRECT RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	99	50	50	55	90
1-2	96	25	25	50	90
1-3	112	40	60	65	100
2-1	80	15	35	40	65
2-2	101	25	50	80	90
2-3	133	25	45	70	90
3-1	72	10	10	10	25
3-2	81	30	40	45	80
3-3	93	10	25	25	70
4-1	91	15	15	35	80
4-2	98	35	55	60	100
4-3	126	50	50	60	95
5-1	101	40	55	75	90
5-2	112	30	70	75	95
5-3	106	45	65	80	90
6-1	100	45	45	80	95
6-2	104	30	55	60	100
6-3	104	50	75	80	100
	AVERAGE	31	46	57	86

CONSISTENCY

FILM NO.	GROUP AVERAGE RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	94	25	55	60	90
1-2	106	45	65	85	90
1-3	107	35	80	85	100
2-1	88	35	45	55	85
2-2	102	25	75	80	95
2-3	127	75	75	75	95
3-1	86	15	35	65	80
3-2	80	30	40	45	80
3-3	82	35	35	50	60
4-1	98	35	70	75	95
4-2	101	50	55	75	95
4-3	119	55	80	85	100
5-1	105	65	65	85	100
5-2	108	60	75	80	95
5-3	105	65	70	80	90
6-1	96	30	40	60	95
6-2	106	40	50	70	100
6-3	105	75	75	90	100
	AVERAGE	44	60	72	91

TABLE 9-B

AREA - CENTRAL MIDWEST (31 Men)

ACCURACY

FILM NO.	BEST APPROX. CORRECT RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	99	45	64	74	94
1-2	100	46	42	68	94
1-3	116	45	55	58	100
2-1	85	0	16	16	68
2-2	107	19	58	68	100
2-3	141	32	55	58	97
3-1	78	6	6	13	48
3-2	87	32	45	74	94
3-3	100	13	16	48	71
4-1	97	2	23	52	81
4-2	104	61	81	87	97
4-3	137	16	23	45	90
5-1	104	52	68	74	97
5-2	115	52	52	78	100
5-3	110	48	64	90	100
6-1	101	39	42	55	90
6-2	105	52	55	74	97
6-3	105	42	52	68	94
	AVERAGE	33	45	61	89

CONSISTENCY

FILM NO.	GROUP AVERAGE RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	98	48	64	74	94
1-2	108	45	68	71	100
1-3	108	23	71	74	100
2-1	98	48	58	71	90
2-2	108	16	58	68	100
2-3	133	36	48	74	97
3-1	94	46	58	64	90
3-2	89	32	64	78	87
3-3	86	42	48	48	87
4-1	108	45	17	78	97
4-2	104	61	81	87	97
4-3	125	43	48	58	94
5-1	107	42	71	71	97
5-2	112	32	71	74	100
5-3	112	52	71	76	100
6-1	100	39	42	76	90
6-2	108	32	68	68	97
6-3	103	39	61	64	94
	AVERAGE	40	59	71	95

TABLE 9-5

AREA - CENTRAL DISTRICT - 194 sqmi

ADDITIVE

ZONE NO.	BASE PERIOD DELAY	min	ALT. DELAY	ALT.
1-1	89	40	84	74
1-2	160	80	87	88
1-3	116	40	48	56
2-1	85	5	12	14
2-2	107	10	14	18
2-3	141	70	86	82
3-1	70	8	0	12
3-2	87	20	47	74
3-3	100	72	16	18
4-1	87	0	42	20
4-2	104	01	01	01
4-3	137	10	36	44
5-1	104	30	29	24
5-2	115	08	05	16
5-3	141	46	44	60
6-1	101	28	42	36
6-2	109	10	10	14
6-3	146	44	32	34
AVERAGE		33	45	61

DEPRECIATED

ZONE NO.	ADDITIONAL DELAY	min	ALT. DELAY	ALT.
1-1	98	40	54	74
1-2	109	40	40	71
1-3	109	30	71	74
2-1	78	10	40	71
2-2	109	14	60	80
2-3	143	40	46	74
3-1	44	44	42	84
3-2	80	80	84	78
3-3	68	44	40	46
4-1	109	44	37	78
4-2	109	40	81	87
4-3	139	40	40	88
5-1	107	44	41	73
5-2	110	32	41	74
5-3	118	80	73	76
6-1	109	20	40	78
6-2	108	20	88	88
6-3	102	30	81	84
AVERAGE		40	59	71

TABLE 9-C

AREA - SOUTHERN MIDWEST (12 Men)

ACCURACY

FILM NO.	BEST APPROX. CORRECT RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	± 20%
1-1	98	42	50	75	92
1-2	99	25	50	50	75
1-3	115	50	58	75	83
2-1	88	42	58	58	75
2-2	110	42	42	75	83
2-3	145	33	58	58	83
3-1	81	33	33	33	58
3-2	81	17	33	33	83
3-3	93	25	25	50	67
4-1	100	33	33	33	83
4-2	108	33	92	92	100
4-3	139	17	33	75	92
5-1	104	25	42	42	75
5-2	116	42	50	67	92
5-3	110	50	50	92	100
6-1	99	50	50	67	83
6-2	103	25	33	33	92
6-3	103	33	67	67	100
	AVERAGE	34	48	60	84

CONSISTENCY

FILM NO.	GROUP AVERAGE RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	94	42	67	75	92
1-2	106	42	67	75	83
1-3	111	58	58	83	83
2-1	96	17	50	58	75
2-2	110	42	42	75	83
2-3	140	50	67	67	83
3-1	87	17	33	33	83
3-2	76	25	42	42	75
3-3	86	50	67	67	83
4-1	115	50	50	67	100
4-2	109	33	58	100	100
4-3	128	50	67	75	92
5-1	111	50	50	75	83
5-2	113	33	58	58	92
5-3	107	50	75	75	100
6-1	88	17	33	50	83
6-2	109	00	42	75	100
6-3	107	50	92	92	100
	AVERAGE	38	57	69	88

TABLE 9-D

AREA - MICHIGAN GROUP (9 Men)

ACCURACY

FILM NO.	BEST APPROX. CORRECT RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	101	78	89	100	100
1-2	102	44	78	78	100
1-3	118	56	89	89	100
2-1	91	22	22	78	89
2-2	115	89	89	100	100
2-3	151	33	44	67	78
3-1	79	0	0	0	78
3-2	89	56	55	56	89
3-3	102	33	44	44	67
4-1	104	0	11	11	89
4-2	112	44	78	78	100
4-3	143	44	44	56	100
5-1	107	11	44	44	89
5-2	118	56	89	89	100
5-3	112	56	78	89	100
6-1	106	33	89	100	100
6-2	110	78	78	100	100
6-3	110	56	56	89	100
	AVERAGE	44	60	70	93

CONSISTENCY

FILM NO.	GROUP AVERAGE RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	102	67	100	100	100
1-2	106	44	67	100	100
1-3	114	89	89	89	100
2-1	100	78	78	89	100
2-2	117	89	100	100	100
2-3	144	44	56	67	100
3-1	93	89	100	100	100
3-2	89	56	56	56	89
3-3	92	0	22	44	100
4-1	121	78	89	100	100
4-2	111	56	56	78	100
4-3	131	22	56	78	100
5-1	114	33	33	56	100
5-2	113	56	89	89	100
5-3	110	67	78	100	100
6-1	104	78	89	89	100
6-2	115	100	100	100	100
6-3	108	33	78	78	100
	AVERAGE	60	74	84	99

TABLE B-3

PART - HIGHLAND GROUP (9 mos)

ACCURACY

FILE NO.	OBSERVED RATE	±5%	±7.5%	±10%
1-1	101	76	89	100
1-2	102	66	76	100
1-3	118	64	88	100
2-1	91	36	52	88
2-2	118	86	89	100
2-3	131	82	84	87
3-1	78	0	0	78
3-2	89	86	86	
3-3	102	71	44	67
4-1	104	0	11	89
4-2	113	64	78	100
4-3	143	44	50	100
5-1	107	11	44	89
5-2	118	88	89	100
6-2	112	82	78	100
6-1	106	82	88	100
6-2	110	71	76	100
6-3	110	64	88	100
AVERAGE		64	66	78

CONSISTENCY

FILE NO.	GROUP ATTRIBUTE RATE	±5%	±7.5%	±10%
1-1	102	87	100	100
1-2	108	64	87	100
1-3	114	80	83	88
2-1	100	73	78	89
2-2	117	89	100	100
2-3	144	44	89	100
3-1	82	82	100	100
3-2	88	76	88	88
3-3	93	0	20	44
4-1	121	73	89	100
4-2	111	82	82	78
4-3	131	82	82	78
5-1	114	80	84	86
5-2	116	80	89	89
6-2	110	87	78	100
6-1	104	78	89	89
6-2	118	100	100	100
6-3	102	82	78	78
AVERAGE		80	84	92

TABLE 10-A

PLACE OF TIME STUDY TRAINING - COLLEGE GROUP (22 Men)

ACCURACY

FILM NO.	BEST APPROX. CORRECT RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	96	45	55	64	91
1-2	98	27	50	64	91
1-3	113	36	55	55	96
2-1	85	14	50	50	82
2-2	107	41	59	59	91
2-3	141	32	50	50	91
3-1	73	14	14	32	50
3-2	78	23	32	50	77
3-3	94	14	23	45	77
4-1	97	36	50	50	68
4-2	105	73	73	91	100
4-3	134	27	54	55	96
5-1	102	36	64	64	86
5-2	112	41	77	77	96
5-3	107	45	77	77	91
6-1	100	41	41	82	86
6-2	103	27	45	45	96
6-3	103	41	73	73	100
	AVERAGE	34	52	60	87

CONSISTENCY

FILM NO.	GROUP AVERAGE RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	96	46	55	64	91
1-2	103	45	68	68	96
1-3	108	14	73	73	96
2-1	90	27	41	41	82
2-2	105	50	50	77	100
2-3	139	32	45	59	91
3-1	88	18	32	50	91
3-2	78	18	27	41	82
3-3	85	23	45	55	86
4-1	109	14	32	86	100
4-2	106	73	73	91	100
4-3	124	55	55	55	100
5-1	106	18	50	73	91
5-2	112	41	17	17	96
5-3	103	41	68	68	91
6-1	92	27	27	45	86
6-2	111	55	55	68	100
6-3	103	41	73	73	100
	AVERAGE	34	50	61	93

TABLE IC-4

Type of Time Study Training - Control Group (5% sec)

ADJUST

File No.	Direct Allowed. Observed Rate	+5%	47.5%	+10%	+20%
1-1	.00	80	58	64	82
1-2	.00	87	59	64	73
1-3	115	89	85	75	98
2-1	.00	114	80	80	78
2-2	107	81	84	88	81
2-3	141	92	90	90	81
3-1	73	74	14	78	10
3-2	78	78	84	80	74
3-3	104	14	83	85	77
4-1	117	98	80	80	86
4-2	100	73	78	81	100
4-3	134	87	84	86	78
5-1	102	98	84	84	86
5-2	118	81	77	77	98
5-3	107	82	97	77	71
6-1	100	81	84	80	86
6-2	108	87	88	86	96
6-3	102	71	73	72	100
Averages		34	82	80	87

CONTINUOUS

File No.	Direct Allowed Rate	+5%	47.5%	+10%	+20%
1-1	98	44	58	64	81
1-2	108	80	84	88	95
1-3	128	78	73	74	89
2-1	100	77	71	42	98
2-2	108	80	80	77	100
2-3	128	78	84	89	91
3-1	88	78	82	80	84
3-2	78	18	87	81	80
3-3	88	78	84	86	88
4-1	108	14	82	86	100
4-2	108	78	74	81	108
4-3	108	86	86	80	100
5-1	108	18	80	74	81
5-2	112	82	17	17	88
5-3	108	84	88	88	81
6-1	98	87	84	88	86
6-2	112	86	88	88	100
6-3	102	74	78	78	100
Averages		84	80	81	92

TABLE 10-B

PLACE OF TIME STUDY TRAINING - COMPANY GROUP (45 Men)

ACCURACY

FILM NO.	BEST APPROX. CORRECT RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	96	45	55	64	91
1-2	98	27	50	64	91
1-3	113	36	55	55	96
2-1	85	14	50	50	82
2-2	107	41	59	59	91
2-3	141	32	50	50	91
3-1	73	14	14	32	50
3-2	82	23	32	50	77
3-3	94	14	23	45	77
4-1	97	36	50	50	68
4-2	105	73	73	91	100
4-3	134	27	54	55	96
5-1	102	36	64	64	86
5-2	112	41	77	77	96
5-3	107	45	77	77	91
6-1	100	41	41	82	86
6-2	103	27	45	45	96
6-3	103	41	73	73	100
	AVERAGE	34	52	60	87

CONSISTENCY

FILM NO.	GROUP AVERAGE RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	96	45	55	64	91
1-2	103	45	68	68	96
1-3	108	14	73	73	96
2-1	90	27	41	41	82
2-2	105	50	50	77	100
2-3	139	32	45	59	91
3-1	88	18	32	50	91
3-2	78	18	27	41	82
3-3	85	23	45	55	86
4-1	109	13	32	86	100
4-2	106	73	73	91	100
4-3	124	55	55	55	100
5-1	106	18	50	73	91
5-2	112	41	17	17	96
5-3	103	41	68	68	91
6-1	92	27	27	45	86
6-2	111	55	55	68	100
6-3	103	41	73	73	100
	AVERAGE	34	50	61	93

TABLE 10-1

PLACE OF TIME AT-BAT TRANSFER - (COMPLETE DEFICIT [40 mos)

ADVANCED

TEAM NO.	DEFICIT DAYS	RATE APPROX.	RT.SP.	LOSE	LOSE
1-1	90	40	95	84	81
1-2	95	47	90	86	81
1-3	113	58	92	88	86
2-1	85	34	90	80	83
2-2	109	51	88	86	81
2-3	141	74	90	88	81
3-1	72	14	94	78	80
3-2	83	36	94	87	77
3-3	84	14	88	84	79
4-1	97	88	90	80	88
4-2	100	78	92	82	100
4-3	104	87	84	88	86
5-1	105	88	94	86	86
5-2	112	91	88	88	86
5-3	107	89	94	87	81
6-1	100	81	91	86	86
6-2	108	87	92	86	86
6-3	113	94	92	86	100
AVERAGE	94	80	89	84	87

DE-ACCELERATION

TEAM NO.	AVERAGE RATE	LOSE	RT.SP.	LOSE	LOSE
1-1	10	40	86	84	81
1-2	108	46	89	88	88
1-3	109	74	92	86	86
2-1	90	34	94	84	80
2-2	105	70	88	88	100
2-3	139	80	88	88	81
3-1	90	78	92	80	84
3-2	74	78	94	84	82
3-3	80	80	90	84	80
4-1	108	78	88	84	100
4-2	108	90	92	84	100
4-3	134	90	88	88	100
5-1	104	86	90	78	84
5-2	118	84	92	82	88
5-3	103	84	88	88	81
6-1	80	80	84	88	88
6-2	111	88	92	84	100
6-3	103	84	92	88	100
AVERAGE	94	80	89	84	84

TABLE 11-A

SIZE OF PLANT - UNDER 200 EMPLOYEES (10 Men)

ACCURACY

FILM NO.	BEST APPROX. CORRECT RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	94	30	70	70	90
1-2	96	30	50	70	90
1-3	11	50	50	90	100
2-1	84	30	40	40	70
2-2	106	10	20	70	100
2-3	139	30	50	50	90
3-1	65	0	10	10	10
3-2	73	20	20	40	70
3-3	84	40	40	40	80
4-1	95	30	30	40	40
4-2	102	70	80	80	90
4-3	131	60	70	80	100
5-1	102	60	70	80	100
5-2	113	10	50	50	90
5-3	107	40	60	60	70
6-1	96	40	40	60	80
6-2	100	40	40	80	90
6-3	100	60	60	80	90
	AVERAGE	35	47	61	90

CONSISTENCY

FILM NO.	GROUP AVERAGE RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	90	10	20	20	90
1-2	105	50	60	80	100
1-3	106	50	70	90	100
2-1	88	40	40	40	80
2-2	106	10	20	70	100
3-3	136	50	50	50	90
3-1	82	20	20	50	70
3-2	72	20	20	40	70
3-3	72	40	40	50	90
4-1	110	50	50	90	100
4-2	100	80	80	80	90
4-3	122	70	70	100	100
5-1	106	20	80	90	100
5-2	111	40	40	60	90
5-3	104	40	60	60	70
6-1	92	20	30	40	70
6-2	105	40	40	60	90
6-3	99	50	60	80	90
	AVERAGE	39	47	59	88

TABLE 11-4

LIST OF PLANT - DENSITY AND DISTRIBUTION (In Acre)

ADVANCED

PLOT NO.	OBSERVED RATE	DENSITY			
1-1	84	80	76	72	70
1-2	88	78	74	72	68
1-3	92	82	78	74	70
2-1	86	82	78	74	70
2-2	94	88	84	80	76
2-3	102	96	92	88	84
3-2	110	104	98	92	88
3-3	88	82	78	74	70
4-1	78	74	70	66	62
4-2	84	80	76	72	68
4-3	90	86	82	78	74
5-1	96	92	88	84	80
5-2	104	98	94	90	86
5-3	112	106	102	96	92
6-1	98	94	90	86	82
6-2	106	100	96	92	88
6-3	114	108	104	98	94
AVERAGE	94	87	83	78	74

INTERMEDIATE

PLOT NO.	OBSERVED RATE	DENSITY			
1-1	90	84	80	76	72
1-2	96	90	86	82	78
1-3	102	96	92	88	84
2-1	94	88	84	80	76
2-2	100	94	90	86	82
2-3	106	100	96	92	88
3-2	112	106	102	96	92
3-3	92	86	82	78	74
4-1	86	82	78	74	70
4-2	92	86	82	78	74
4-3	98	92	88	84	80
5-1	104	98	94	90	86
5-2	110	104	98	94	90
5-3	116	110	104	98	94
6-1	102	96	92	88	84
6-2	110	104	98	94	90
6-3	118	112	106	100	96
AVERAGE	98	92	87	83	78

TABLE 11-B

SIZE OF PLANT - 300 to 1000 EMPLOYEES (37 Men)

ACCURACY

FILM NO.	BEST APPROX. CORRECT RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	99	57	68	76	95
1-2	101	34	35	57	92
1-3	117	46	68	73	97
2-1	86	16	24	32	68
2-2	108	24	59	62	97
2-3	142	38	43	57	97
3-1	79	8	14	19	63
3-2	88	27	46	59	92
3-3	101	23	24	30	81
4-1	97	16	19	46	73
4-2	105	76	78	86	97
4-3	134	24	41	41	92
5-1	105	57	59	70	97
5-2	116	59	62	84	100
5-3	110	57	70	95	100
6-1	104	43	59	59	100
6-2	108	32	76	78	100
6-3	108	41	76	81	100
	AVERAGE	37	51	61	91

CONSISTENCY

FILM NO.	GROUP AVERAGE RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	99	57	68	76	95
1-2	108	46	68	73	97
1-3	110	46	51	86	100
2-1	98	41	51	65	92
2-2	110	41	46	81	97
2-3	134	38	51	57	92
3-1	92	43	51	65	89
3-2	90	14	49	51	81
3-3	90	27	51	54	81
4-1	109	46	51	84	95
4-2	105	76	78	86	97
4-3	126	51	57	65	89
5-1	108	27	65	65	100
5-2	112	35	81	84	100
5-3	112	62	76	81	100
6-1	101	43	49	62	97
6-2	110	57	59	92	100
6-3	108	41	76	81	100
	AVERAGE	44	60	73	95

TABLE 11-3

TIME OF TRAVEL - BUS TO AUTO DISTRIBUTION (AM Peak)

Zone No.	Transit Time	%	Auto Time	%
1-1	06	06	13	08
1-2	10	10	17	10
1-3	14	14	21	12
2-1	09	09	15	09
2-2	13	13	19	11
2-3	17	17	23	13
3-1	12	12	18	10
3-2	16	16	22	12
3-3	20	20	26	15
4-1	15	15	21	12
4-2	19	19	25	14
4-3	23	23	29	16
5-1	18	18	24	14
5-2	22	22	28	16
5-3	26	26	32	18
6-1	21	21	27	15
6-2	25	25	31	18
6-3	29	29	35	20
7-1	24	24	30	17
7-2	28	28	34	19
7-3	32	32	38	22
8-1	27	27	33	19
8-2	31	31	37	21
8-3	35	35	41	23
9-1	30	30	36	21
9-2	34	34	40	23
9-3	38	38	44	25
10-1	33	33	39	22
10-2	37	37	43	25
10-3	41	41	47	27
11-1	36	36	42	24
11-2	40	40	46	26
11-3	44	44	50	28
12-1	39	39	45	26
12-2	43	43	49	28
12-3	47	47	53	30
13-1	42	42	48	27
13-2	46	46	52	30
13-3	50	50	56	32
14-1	45	45	51	29
14-2	49	49	55	31
14-3	53	53	59	33
15-1	48	48	54	31
15-2	52	52	58	33
15-3	56	56	62	35
16-1	51	51	57	33
16-2	55	55	61	35
16-3	59	59	65	37
17-1	54	54	60	34
17-2	58	58	64	36
17-3	62	62	68	38
18-1	57	57	63	36
18-2	61	61	67	38
18-3	65	65	71	40
19-1	60	60	66	37
19-2	64	64	70	39
19-3	68	68	74	41
20-1	63	63	69	39
20-2	67	67	73	41
20-3	71	71	77	43
21-1	66	66	72	40
21-2	70	70	76	42
21-3	74	74	80	44
22-1	69	69	75	42
22-2	73	73	79	44
22-3	77	77	83	46
23-1	72	72	78	43
23-2	76	76	82	45
23-3	80	80	86	47
24-1	75	75	81	45
24-2	79	79	85	47
24-3	83	83	89	49
25-1	78	78	84	46
25-2	82	82	88	48
25-3	86	86	92	50
26-1	81	81	87	48
26-2	85	85	91	50
26-3	89	89	95	52
27-1	84	84	90	49
27-2	88	88	94	51
27-3	92	92	98	53
28-1	87	87	93	51
28-2	91	91	97	53
28-3	95	95	101	55
29-1	90	90	96	52
29-2	94	94	100	54
29-3	98	98	104	56
30-1	93	93	99	54
30-2	97	97	103	56
30-3	101	101	107	58
31-1	96	96	102	55
31-2	100	100	106	57
31-3	104	104	110	59
32-1	99	99	105	57
32-2	103	103	109	59
32-3	107	107	113	61
33-1	102	102	108	58
33-2	106	106	112	60
33-3	110	110	116	62
34-1	105	105	111	60
34-2	109	109	115	62
34-3	113	113	119	64
35-1	108	108	114	61
35-2	112	112	118	63
35-3	116	116	122	65
36-1	111	111	117	63
36-2	115	115	121	65
36-3	119	119	125	67
37-1	114	114	120	64
37-2	118	118	124	66
37-3	122	122	128	68
38-1	117	117	123	65
38-2	121	121	127	67
38-3	125	125	131	69
39-1	120	120	126	66
39-2	124	124	130	68
39-3	128	128	134	70
40-1	123	123	129	67
40-2	127	127	133	69
40-3	131	131	137	71
41-1	126	126	132	68
41-2	130	130	136	70
41-3	134	134	140	72
42-1	129	129	135	69
42-2	133	133	139	71
42-3	137	137	143	73
43-1	132	132	138	70
43-2	136	136	142	72
43-3	140	140	146	74
44-1	135	135	141	71
44-2	139	139	145	73
44-3	143	143	149	75
45-1	138	138	144	72
45-2	142	142	148	74
45-3	146	146	152	76
46-1	141	141	147	73
46-2	145	145	151	75
46-3	149	149	155	77
47-1	144	144	150	74
47-2	148	148	154	76
47-3	152	152	158	78
48-1	147	147	153	75
48-2	151	151	157	77
48-3	155	155	161	79
49-1	150	150	156	76
49-2	154	154	160	78
49-3	158	158	164	80
50-1	153	153	159	77
50-2	157	157	163	79
50-3	161	161	167	81
51-1	156	156	162	78
51-2	160	160	166	80
51-3	164	164	170	82
52-1	159	159	165	79
52-2	163	163	169	81
52-3	167	167	173	83
53-1	162	162	168	80
53-2	166	166	172	82
53-3	170	170	176	84
54-1	165	165	171	81
54-2	169	169	175	83
54-3	173	173	179	85
55-1	168	168	174	82
55-2	172	172	178	84
55-3	176	176	182	86
56-1	171	171	177	83
56-2	175	175	181	85
56-3	179	179	185	87
57-1	174	174	180	84
57-2	178	178	184	86
57-3	182	182	188	88
58-1	177	177	183	85
58-2	181	181	187	87
58-3	185	185	191	89
59-1	180	180	186	86
59-2	184	184	190	88
59-3	188	188	194	90
60-1	183	183	189	87
60-2	187	187	193	89
60-3	191	191	197	91
61-1	186	186	192	88
61-2	190	190	196	90
61-3	194	194	200	92
62-1	189	189	195	89
62-2	193	193	199	91
62-3	197	197	203	93
63-1	192	192	198	90
63-2	196	196	202	92
63-3	200	200	206	94
64-1	195	195	201	91
64-2	199	199	205	93
64-3	203	203	209	95
65-1	198	198	204	92
65-2	202	202	208	94
65-3	206	206	212	96
66-1	201	201	207	93
66-2	205	205	211	95
66-3	209	209	215	97
67-1	204	204	210	94
67-2	208	208	214	96
67-3	212	212	218	98
68-1	207	207	213	95
68-2	211	211	217	97
68-3	215	215	221	99
69-1	210	210	216	96
69-2	214	214	220	98
69-3	218	218	224	100
70-1	213	213	219	97
70-2	217	217	223	99
70-3	221	221	227	101
71-1	216	216	222	98
71-2	220	220	226	100
71-3	224	224	230	102
72-1	219	219	225	99
72-2	223	223	229	101
72-3	227	227	233	103
73-1	222	222	228	100
73-2	226	226	232	102
73-3	230	230	236	104
74-1	225	225	231	101
74-2	229	229	235	103
74-3	233	233	239	105
75-1	228	228	234	102
75-2	232	232	238	104
75-3	236	236	242	106
76-1	231	231	237	103
76-2	235	235	241	105
76-3	239	239	245	107
77-1	234	234	240	104
77-2	238	238	244	106
77-3	242	242	248	108
78-1	237	237	243	105
78-2	241	241	247	107
78-3	245	245	251	109
79-1	240	240	246	106
79-2	244	244	250	108
79-3	248	248	254	110
80-1	243	243	249	107
80-2	247	247	253	109
80-3	251	251	257	111
81-1	246	246	252	108
81-2	250	250	256	110
81-3	254	254	260	112
82-1	249	249	255	109
82-2	253	253	259	111
82-3	257	257	263	113
83-1	252	252	258	110
83-2	256	256	262	112
83-3	260	260	266	114
84-1	255	255	261	111
84-2	259	259	265	113
84-3	263	263	269	115
85-1	258	258	264	112
85-2	262	262	268	114
85-3	266	266	272	116
86-1	261	261	267	113
86-2	265	265	271	115
86-3	269	269	275	117
87-1	264	264	270	114
87-2	268	268	274	116
87-3	272	272	278	118
88-1	267	267	273	115
88-2	271	271	277	117
88-3	275	275	281	119
89-1	270	270	276	116
89-2	274	274	280	118
89-3	278	278	284	120
90-1	273	273	279	117
90-2	277	277	283	119
90-3	281	281	287	121
91-1	276	276	282	118
91-2	280	280	286	120
91-3	284	284	290	122
92-1	279	279	285	119
92-2	283	283	289	121
92-3	287	287	293	123
93-1	282	282	288	120
93-2	286	286	292	122
93-3	290	290	296	124
94-1	285	285	291	121
94-2	289	289	295	123
94-3	293	293	299	125
95-1	288	288	294	122
95-2	292	292	298	124
95-3	296	296	302	126
96-1	291	291	297	123
96-2	295	295	301	125
96-3	299	299	305	127
97-1	294	294	300	124
97-2	298	298	304	126
97-3	302	302	308	128
98-1	297	297	303	125
98-2	301	301	307	127
98-3	305	305	311	129
99-1	300	300	306	126
99-2	304	304	310	128
99-3	308	308	314	130
100-1	303	303	309	127
100-2	307	307	313	129
100-3	311	311	317	131
101-1	306	306	312	128
101-2	310	310	316	130
101-3	314	314	320	132
102-1	309	309	315	129
102-2	313	313	319	131
102-3	317	317	323	133
103-1	312	312	318	130
103-2	316	316	322	132
103-3	320	320	326	134
104-1	315	315	321	131
104-2	319	319	325	133
104-3	323	323	329	135
105-1	318	318	324	132
105-2	322	322	328	134
105-3	326	326	332	136
106-1	321	321	327	133
106-2	325	325	331	135
106-3	329	329	335	137
107-1	324	324	330	134
107-2	328	328	334	136
107-3	332	332	338	138
108-1	327	327	333	135
108-2	331	331	337	137
108-3	335	335	341	139
109-1	330	330	336	136
109-2	334	334	340	138
109-3	338	338	344	140
110-1	333	333	339	137
110-2	337	337	343	139
110-3	341	341	347	141
111-1	336	336	342	138
111-2	340	340	346	140
111-3	344	344	350	142
112-1	339	339	345	139
112-2	343	343	349	141
112-3	347	347	353	143
113-1	342	342	348	140
113-2	346	346	352	142
113-3	350	350	356	144
114-1	345	345	351	141
114-2	349	349	355	143
114-3	353	353	359	145
115-1	348	348	354	142
115-2	352	352	358	144
115-3	356	356	362	146
116-1	351	351	357	143
116-2	355	355	361	145
116-3	359	359	365	147
117-1	354	354	360	144
117-2	358	358	364	146
117-3	362	362	368	148
118-1	357	357	363	145
118-2	361	361	367	147
118-3	365	365	371	149
119-1	360	360	366	146
119-2	364	364	370	148
119-3	368	368	374	150
120-1	363	363	369	147
120-2	367	367	373	149
120-3	371	371	377	151
121-1	366	366	372	148
121-2	370	370	376	150
121-3	374	374	380	152
122-1	369	369	375	149
122-2	373	373	379	151
122-3	377	377	383	153
123-1	372	372	378	150
123-2	376	376	382	152
123-3	380	380	386	154
124-1	375	375	381	151
124-2	379	379	385	153
124-3	383	383	389	155
125-1	378	378	384	152
125-2	382	382	388	154
125-3	386	386	392	156
126-1	381	381	387	153
126-2	385	385	391	155
126-3	389	389	395	157
127-1	384	384	390	154
127-2	388	388	394	156
127-3	392	392	398	158
128-1	387	387	393	155
128-2	391	391	397	157
128-3	395	395	401	159
129-1	390	390	396	156
129-2	394	394	400	158
129-3	398	398	404	160
130-1	393	393	399	157
130-2	397	397	403	159
130-3	401	401	407	161
131-1	396	396	402	158
131-2	400	400	406	160
131-3	404	404	410	162
132-1	399	399	405	159
132-2	403	403	409	161
132-3	407	407	413	163
133-1	402	402	408	160
133-2	406	406	412	162
133-3	410	410	416	164
134-1	405	405	411	161
134-2	409	409	415	163
134-3	413	413	419	165
135-1	408	408	414	162
135-2	412	412	418	164
135-3	416	416	422	166
136-1	411	411	417	163
136-2	415	415	421	165
136-3	419	419	425	167
137-1	414	414	420	164
137-2	418	418	424	166
137-3	422	422	428	168
138-1	417	417	423	165
138-2	421	421	427	167
138-3	425	425	431	169
139-1	420	420	426	166
139-2	424	424	430	168
139-3	428	428	434	170
140-1	423	423	429	167
140-2	427	427	433	169
140-3	431	431	437	171
141-1	426	426	432	168
141-2	430	430	436	170
141-3	434	434	440	172
142-1	429	429	435	169
142-2	433	433	439	171
142-3	437	437	443	173
143-1	432	432	438	170
143-2	436	436	442	172
143-3	440	440	446	174
144-1	435	435	441	171
144-2	439	439	445	173
144-3	443	443	449	175
145-1	438	438	444	172
145-2	442	442	448	174
145-3	446	446	452	176
146-1	441	441	447	173
146-2	445	445	451	175
146-3	449	449	455	177
147-1	444	444	450	174
147-2	448	448	454	176
147-3	452	452	458	178
148-1	447	447	453	175
148-2	451	451	457	177
148-3	455	455	461	179
149-1	450	450	456	176
149-2	454	454	460	178
149-3	458	458	464	180
150-1	453	453	459	177
150-2	457	457	463	179
150-3	461	461	467	181
151-1	456	456	462	178
151-2	460	460	466	180
151-3	464	464	470	182
152-1	459	459	465	179
152-2	463	463	469	181
152-3	467	467	473	183
153-1	462	462	468	180
153-2	466	466	472	182
153-3	470	470	476	184
154-1	465	465	471	181
154-2	469	469	475	183
154-3	473	473	479	185
155-1	468	468	474	182
155-2	472	472	478	184
155-3	476	476	482	186
156-1	471	471	477	183
156-2	475	475	481	185
156-3	479	479	485	187
157-1	474	474	480	184
157-2	478	478	484	186
157-3	482	482	488	188
158-1	477	477	483	185
158-2	481	481	487	187
158-3	485	485	491	189
159-1	480	480	486	186
159-2	484	484	490	188
159-3	488	488	494	190
160-1	483	483	489	187
160-2	487	487	493	189
160-3	491	491	497	191
161-1	486	486	492	188
161-2	490	490	496	190
161-3	494	494	500	192
162-1	489	489	495	189
162-2	493	493	499	191
162-3	497	497	503	193
163-1	492	492	498	190
163-2	496	496	502	192
163-3	500	500	506	194
164-1	495	495	501	191
164-2	499	499	505	193
164-3	503	503	509	195
165-1	498	498	504	192
165-2	502	502	508	194
165-3	506	506	512	196
166-1	501	501	507	193
166-2	505	505	511	195
166-3	509	509	515	197
167-1	504	504	510	194
167-2	508	508	514	196
167-3	512	512	518	198
168-1	507	507	513	195
168-2	511	511	517	197
168-3	515	515	521	199
169-1	510	510	516	196
169-2	514	514	520	198
169-3	518	518	524	200
170-1	513	513	519	197
170-2	517	517	523	199
170-3	521	521	527	201
171-1	516	516	522	198
171-2	520	520	526	200
171-3	524	524	530	202
172-1	519	519	525	199
172-2	523	523	529	201
172-3	527	527	533	203
173-1	522	522	528	200
173-2	526	526	532	202
173-3	530	530	536	204
174-1	525	525	531	201
174-2	529	529	535	203
174-3	533	533	539	205
175-1	528	528	534	202
175-2	532	532	538	204
175-3	536	536	542	206
176-1	531	531	537	203
176-2	535	535	541	205
176-3	539	539	545	207
177-1	534	534	540	204
177-2	538	538	544	206
177-3	542	542	548	208
178-1	537	537	543	205
178-2	541	541	547	207
178-3	545	545	551	209
179-1	540	540	546	206
179-2	544	544	550	208
179-3	548	548	554	210
180-1	543	543	549	207
180-2	547	547	553	209
180-3	551	551	557	211
181-1	546	546	552	208
181-2	550	550	556	210
181-3	554	554	560	212
182-1	549	549	555	209
182-2	553	553	559	211
182-3	557	557	563	213
183-1	552	552	558	210
183-2	556	556	562	212
183-3	560	560	566	214
184-1	555	555	561	211
184-2	559	559	565	213
184-3	563	563	569	215
185-1	558	558	564	212
185-2	562	562	568	214
185-3	566	566	572	216
186-1	561	561	567	213
186-2	565	565	571	215
186-3	569	569	575	217
187-1	564	564	570	214
187-2	568	568	574	216
187-3	572	572	578	218
188-1	567	567	573	215
188-2	571	571	577	217
188-3	575	575	581	219
189-1	570	570	576	216
189-2	574	574	580	218
189-3	578	578	584	220
190-1	573	573	579	217
190-2	577	577	583	219
190-3	581	581	587	221
191-1	576	576	582	218
191-2	580	580	586	220
191-3	584	584	590	222
192-1	579	579	585	219
192-2	583	583	589	221
192-3	587	587	593	223
193-1	582	582	588	220
193-2	586	586	592	222
193-3	590	590	596	224
194-1	585	585	591	221
194-2	589	589	595	223
194-3	593	593	599	225
195-1	588	588	594	222
195-2	592	592	598	224
195-3	596	596	602	226
196-1	591	591	597	223
196-2	595	595	601	225
196-3	599	599	605	227
197-1	594	594	600	224
197-2	598	598	604	226
197-3	602	602	608	228
198-1	597	597	603	225
198-2	601	601	607	227
198-3	605	605	611	229
199-1	600	600	606	226
199-2	604	604	610	228
199-3	608	608	614	230
200-1	603	603	609	227
200-2	607	607	613	229
200-3	611	611	617	231
201-1	606	606	612	228
201-2	610	610	616	230
201-3	614	614	620	232
202-1	609	609	615	229
202-2	613	613	619	231
202-3	617	617	623	233
203-1	612	612	618	230
203-2	616	616	622	232
203-3	620	620	626	234
204-1	615	615	621	231
204-2	619	619	625	233
204-3	623	623	629	235
205-1	618	618	624	232
205-2	622	622	628	234
205-3	626	626	632	236
206-1	621	621	627	233
206-2	625	625	631	235
206-3	629	629	635	237
207-1	624	624	630	234
207-2	628	628	634	236
207-3	632	632	638	238
208-1	627	627	633	235
208-2	631	631	637	237
208-3	635	635	641	239
209-1	630	630	636	236
209-2	634	634	640	238
209-3	638	638	644	240
210-1	633	633	639	237
210-2	637	637	643	239
210-3	641	641	647	241
211-1	636	636	642	238
211-2	640	640	646	240
211-3	644	644	650	242
212-1	639	639	645	239
212-2	643	643	649	241
212-3	647	647	653	243
213-1	642	642	648	240
213-2	646	646	652	242
213-3	650	650	656	244
214-1	645	645	651	241
214-2	649	649	655	243
214-3	653	653	659	245
215-1	648	648	654	242
215-2	652	652	658	244
215-3	656	656	662	246
216-1	651	651	657	243
216-2	655	655	661	245
216-3	659	659	665	247
217-1	654	654	660	244
217-2	658	658	664	246
217-3	662	662	668	248
218-1	657	657	663	245
218-2	661	661	667	247
218-3	665	665	671	249
219-1	660	660	666	246
219-2	664	664	670	248
219-3	668	668	674	250
220-1	663	663	669	247
220-2	667	667	673	249
220-3	671	671	677	251
221-1	666	666	672	248
221-2	670

TABLE 11-C

SIZE OF PLANT - OVER 1000 EMPLOYEES (21 Men)

ACCURACY

FILM NO.	BEST APPROX. CORRECT RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	97	28	38	62	95
1-2	98	28	57	62	90
1-3	114	38	48	52	90
2-1	83	19	19	43	86
2-2	105	43	48	72	95
2-3	138	14	24	48	90
3-1	73	19	19	33	62
3-2	82	19	28	57	86
3-3	94	10	14	33	76
4-1	96	24	38	67	72
4-2	104	43	62	62	100
4-3	133	19	33	48	90
5-1	102	33	62	72	81
5-2	113	33	62	67	95
5-3	107	38	76	76	100
6-1	99	48	48	62	90
6-2	102	24	43	52	95
6-3	102	28	48	62	100
	AVERAGE	28	43	57	89

CONSISTENCY

FILM NO.	GROUP AVERAGE RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	97	28	38	62	95
1-2	105	67	72	90	90
1-3	107	24	81	81	90
2-1	91	33	52	67	86
2-2	105	43	48	72	95
2-3	133	14	28	52	90
3-1	90	38	47	48	95
3-2	81	19	33	38	90
3-3	82	48	48	62	81
4-1	104	52	57	62	90
4-2	107	38	81	81	100
4-3	124	24	24	33	90
5-1	109	28	38	72	90
5-2	108	52	72	81	95
5-3	105	62	72	81	100
6-1	94	28	67	67	95
6-2	107	19	57	57	95
6-3	103	28	48	62	100
	AVERAGE	36	53	65	93

TABLE 17-2

LIFE OF PLANT - (USE 1000 RATIO TESTS (27 RUNS)

ADDENDUM

FILE NO.	SHOT ADDED. CONCRETE MATE				
1-1	97	15	48	63	95
1-2	98	10	57	67	90
1-3	114	22	49	73	80
2-1	85	19	59	68	85
2-2	105	43	47	75	98
2-3	129	14	74	45	80
3-1	73	19	19	35	61
3-2	83	14	28	67	95
3-3	94	19	15	73	76
4-1	88	24	35	67	79
4-2	104	44	89	69	100
4-3	129	19	84	40	90
5-1	109	25	73	79	81
5-2	115	24	65	87	98
6-3	107	79	75	76	100
8-1	90	46	85	85	96
8-2	109	64	45	35	85
8-3	109	29	68	84	100
AVERAGE		28	45	67	88

CONCLUDING

FILE NO.	DESIGN AVERAGE MATE				
1-1	97	28	36	62	95
1-2	100	27	73	70	90
1-3	107	34	63	61	90
2-1	91	23	58	69	88
2-2	108	43	48	78	96
2-3	128	14	88	82	90
3-1	80	30	47	40	96
3-2	81	19	85	58	90
3-3	98	40	88	80	83
4-1	104	23	87	81	88
4-2	107	36	81	71	100
4-3	124	14	74	42	90
5-1	108	36	88	73	90
5-2	108	23	73	41	88
5-3	108	23	73	81	100
6-1	94	40	87	87	96
6-2	127	14	87	37	85
6-3	109	20	28	72	100
AVERAGE		28	65	68	92

TABLE 12-A

SIZE OF TOWN - UNDER 5000 (17 Men)

ACCURACY

FILM NO.	BEST APPROX. CORRECT RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±30%
1-1	100	47	47	76	88
1-2	101	34	24	47	88
1-3	117	41	76	82	100
2-1	85	18	35	35	71
2-2	107	18	53	53	100
2-3	141	53	76	76	100
3-1	75	0	0	0	41
3-2	84	29	41	41	82
3-3	96	29	35	35	76
4-1	98	24	47	59	82
4-2	106	41	76	94	100
4-3	136	24	29	65	100
5-1	105	65	65	76	100
5-2	116	53	59	76	100
5-3	111	53	65	88	94
6-1	102	29	59	59	94
6-2	106	41	47	59	94
6-3	106	35	71	71	94
	AVERAGE	35	50	61	89

CONSISTENCY

FILM NO.	GROUP AVERAGE RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±30%
1-1	96	35	53	65	82
1-2	111	59	58	76	100
1-3	112	53	71	71	100
2-1	94	24	41	65	94
2-2	111	41	41	65	100
2-3	133	59	71	94	100
3-1	92	47	59	65	94
3-2	84	29	41	41	82
3-3	82	41	41	76	82
4-1	108	29	76	76	100
4-2	104	59	76	88	100
4-3	129	29	65	88	100
5-1	110	47	47	94	100
5-2	114	53	71	76	100
5-3	108	24	65	76	94
6-1	98	24	41	59	88
6-2	111	53	53	82	94
6-3	105	71	71	71	94
	AVERAGE	43	58	74	95

TABLE 12-B

SIZE OF TOWN - 5,000 to 10,000 (7 Men)

ACCURACY

FILE NO.	BEST APPROX. CORRECT RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	99	57	72	72	100
1-2	100	57	57	72	86
1-3	116	57	72	72	100
2-1	80	29	29	43	57
2-2	100	43	57	100	100
2-3	132	57	72	86	100
3-1	72	0	0	0	0
3-2	81	14	14	29	100
3-3	94	43	43	57	72
4-1	93	14	14	14	72
4-2	101	14	14	29	86
4-3	129	57	72	72	100
5-1	103	14	57	57	86
5-2	114	43	72	86	100
5-3	108	72	86	100	100
6-1	103	43	43	43	100
6-2	107	14	43	57	100
6-3	107	72	86	86	100
	AVERAGE	39	50	59	87

CONSISTENCY

FILE NO.	GROUP AVERAGE RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	95	57	57	86	100
1-2	108	29	43	57	100
1-3	112	29	72	86	100
2-1	92	14	14	43	72
2-2	103	14	86	100	100
2-3	123	43	57	86	100
3-1	88	43	57	57	86
3-2	84	29	57	57	100
3-3	79	14	29	29	86
4-1	108	57	72	72	100
4-2	100	14	14	43	100
4-3	120	57	57	100	100
5-1	109	29	57	57	100
5-2	109	29	72	86	100
5-3	108	72	86	100	100
6-1	94	29	72	86	100
6-2	106	14	43	72	100
6-3	108	72	86	86	100
	AVERAGE	36	57	72	97

TABLE 12-B

SIZE OF TOWN - 5,000 to 10,000 (Urban)

ADDENDUM

TIME NO.	HOUSE APPROX. OCCUPANCY DATE	%	%	%	%
1-1	98	87	78	72	100
1-2	100	87	87	72	86
1-3	114	87	78	72	100
2-1	80	78	78	82	67
2-2	100	82	87	100	100
2-3	118	87	78	86	100
3-1	78	0	0	0	0
3-2	91	14	14	86	100
3-3	94	82	82	87	78
4-1	98	14	14	14	78
4-2	101	14	14	86	86
4-3	118	87	72	72	100
5-1	108	14	87	87	86
5-2	114	82	78	86	100
5-3	108	72	86	100	100
6-1	105	82	82	82	100
6-2	107	14	82	87	100
6-3	107	78	86	86	100

AVERAGE	98	80	78	87

ADDENDUM

TIME NO.	ABSOLUTE RATE	%	%	%	%
1-1	98	87	87	86	100
1-2	108	86	87	87	100
1-3	112	87	73	86	100
2-1	92	14	14	82	73
2-2	100	14	86	100	100
2-3	102	82	87	86	100
3-1	86	82	87	87	86
3-2	94	86	87	87	100
3-3	98	87	87	86	100
4-1	108	87	72	73	100
4-2	120	14	14	86	100
4-3	120	87	87	100	100
5-1	102	87	87	87	100
5-2	107	78	73	86	100
5-3	107	78	86	100	100
6-1	104	78	72	86	100
6-2	100	14	14	73	100
6-3	108	87	86	86	100

AVERAGE	98	87	78	87

TABLE 12-C

SIZE OF TOWN - 10,000 - 35,000 (18 Men)

ACCURACY

FILM NO.	BEST APPROX. CORRECT RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	95	56	56	84	89
1-2	96	39	39	50	89
1-3	111	44	50	84	94
2-1	82	17	17	33	72
2-2	103	39	67	67	94
2-3	136	17	22	39	94
3-1	75	22	44	44	50
3-2	84	22	28	28	78
3-3	96	28	33	39	62
4-1	96	22	39	67	84
4-2	103	39	72	78	89
4-3	132	22	28	50	78
5-1	102	44	67	67	78
5-2	113	39	67	67	94
5-3	108	39	61	67	100
6-1	100	44	44	78	89
6-2	103	44	56	62	94
6-3	103	22	61	67	94
	AVERAGE	33	47	59	85

CONSISTENCY

FILM NO.	GROUP AVERAGE RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	93	39	56	67	89
1-2	104	33	67	78	94
1-3	106	28	56	84	100
2-1	92	39	56	67	84
2-2	102	39	67	67	94
2-3	132	11	17	50	94
3-1	89	6	28	44	84
3-2	84	22	28	28	28
3-3	85	6	33	33	78
4-1	107	50	72	72	94
4-2	106	44	67	84	94
4-3	121	50	50	67	94
5-1	106	33	61	67	84
5-2	109	33	50	84	94
5-3	109	39	39	78	100
6-1	93	50	67	67	84
6-2	107	17	78	78	94
6-3	106	28	50	84	94
	AVERAGE	32	52	66	88

TABLE 19-0

SITE OF TORT - 10,000 - 50,000 (12 km)

ACCURACY

FILE NO.	CURRENT RATE	MOST APPROX. *50%	*67.5%	*10%	*30%
1-1	95	90	96	94	88
1-2	98	78	80	90	82
1-3	111	94	80	94	84
2-1	84	47	47	82	72
2-2	108	49	87	87	78
2-3	126	47	78	93	84
3-1	78	82	84	44	80
3-2	84	87	78	85	76
3-3	96	82	78	92	82
4-1	94	78	78	87	84
4-2	102	87	74	76	68
4-3	124	84	78	80	78
5-1	102	84	87	87	78
5-2	118	78	87	87	84
5-3	108	78	84	87	100
6-1	100	84	84	78	88
6-2	102	84	88	88	94
6-3	108	82	88	88	94
	AVERAGE	77	87	89	85

CONSISTENCY

FILE NO.	OBTAIN AVERAGE RATE	*50%	*67.5%	*10%	*30%
1-1	93	78	86	87	88
1-2	104	82	87	78	94
1-3	106	78	86	94	100
2-1	86	78	88	89	86
2-2	102	84	87	87	94
2-3	122	84	87	80	94
3-1	82	84	88	88	84
3-2	94	78	88	88	78
3-3	90	78	88	78	78
4-1	112	78	84	73	84
4-2	108	84	87	84	84
4-3	110	84	84	87	86
5-1	106	82	81	87	84
5-2	102	84	80	84	84
5-3	102	84	84	78	100
6-1	94	80	87	80	84
6-2	107	82	78	78	84
6-3	106	78	80	84	78
	AVERAGE	84	84	86	86

TABLE 12-D

SIZE OF TOWN - 25,000 - 50,000 (11 Men)

ACCURACY

FILM NO.	BEST APPROX. CORRECT RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	99	64	64	64	100
1-2	100	73	73	82	100
1-3	116	36	45	54	100
2-1	85	9	45	45	82
2-2	107	45	64	64	100
2-3	141	9	36	36	91
3-1	75	9	18	18	73
3-2	85	0	73	73	91
3-3	97	9	9	27	91
4-1	96	18	27	64	73
4-2	103	82	82	82	100
4-3	132	18	45	54	100
5-1	103	54	73	73	100
5-2	114	36	73	73	91
5-3	108	36	73	73	100
6-1	103	54	91	91	100
6-2	107	18	64	64	100
6-3	107	36	82	82	100
	AVERAGE	34	58	62	94

CONSISTENCY

FILM NO.	GROUP AVERAGE RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	103	45	91	91	100
1-2	107	73	100	100	100
1-3	106	27	73	91	100
2-1	95	64	64	82	100
2-2	110	45	45	82	100
2-3	133	27	45	54	91
3-1	89	54	73	82	100
3-2	85	0	73	73	91
3-3	86	54	73	73	91
4-1	109	36	54	82	100
4-2	104	82	91	91	100
4-3	121	36	64	91	100
5-1	103	54	73	73	100
5-2	110	64	64	91	91
5-3	111	36	45	73	100
6-1	102	54	91	91	100
6-2	110	45	45	91	100
6-3	104	36	64	64	100
	AVERAGE	46	68	82	98

TABLE IV-2

CLASS OF 1938 - 30,000 - PERCENTILE RANK

TYPE NO.	CORRECT RATE	MEAN	17.5%	MEDIAN	80%
I-1	94	84	94	94	100
I-2	100	92	92	89	100
I-3	116	86	42	94	100
I-4	86	8	42	46	88
I-5	107	87	84	88	100
I-6	143	-	33	86	81
I-7	92	8	16	18	92
I-8	88	0	78	78	84
I-9	82	9	87	87	87
I-10	88	18	84	84	72
I-11	109	88	88	89	100
I-12	121	88	14	34	100
I-13	108	84	74	74	100
I-14	114	84	78	82	81
I-15	108	84	72	73	100
I-16	109	88	81	81	100
I-17	107	86	86	84	100
I-18	107	86	82	88	100
AVERAGE	94	84	84	84	94

CORRELATIONS

TYPE NO.	AVERAGE RATE	MEAN	47.5%	MEDIAN	80%
I-1	108	44	81	81	100
I-2	107	72	100	100	100
I-3	106	37	73	73	100
I-4	98	84	84	88	100
I-5	110	48	88	88	100
I-6	128	87	48	84	81
I-7	89	84	82	82	100
I-8	88	0	78	78	81
I-9	88	84	78	78	81
I-10	106	88	84	84	100
I-11	104	88	84	84	100
I-12	121	84	84	84	100
I-13	108	84	84	84	100
I-14	110	84	84	84	100
I-15	112	76	76	76	100
I-16	105	84	84	84	100
I-17	110	48	84	84	100
I-18	104	80	84	84	100
AVERAGE	46	84	84	84	96

TABLE 12-E

SIZE OF TOWN - 50,000 - 100,000 (7 Men)

ACCURACY

FILM NO.	BEST APPROX. CORRECT RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	99	72	72	72	100
1-2	100	57	57	57	86
1-3	116	57	57	72	72
2-1	91	0	0	43	43
2-2	114	57	57	57	72
2-3	150	14	43	57	86
3-1	78	0	0	29	43
3-2	88	14	14	29	86
3-3	101	29	29	29	43
4-1	98	0	14	14	43
4-2	105	72	72	72	100
4-3	135	29	29	29	86
5-1	107	14	57	57	86
5-2	118	29	29	57	100
5-3	113	29	72	86	100
6-1	99	43	57	57	86
6-2	103	14	29	29	100
6-3	103	57	86	86	100
	AVERAGE	33	43	52	79

CONSISTENCY

FILM NO.	GROUP AVERAGE RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	97	72	72	72	100
1-2	103	43	57	57	72
1-3	114	57	72	72	72
2-1	106	14	57	57	57
2-2	113	14	57	57	72
2-3	142	43	43	43	72
3-1	93	29	57	72	86
3-2	81	14	29	29	57
3-3	96	29	29	29	72
4-1	113	14	57	57	86
4-2	104	43	72	72	100
4-3	124	43	43	43	86
5-1	116	43	57	57	86
5-2	115	29	29	57	100
5-3	108	43	86	86	100
6-1	94	0	43	43	57
6-2	106	14	29	57	100
6-3	106	29	86	86	100
	AVERAGE	32	54	58	82

TABLE 19-2

[one of type - 60,000 - 100,000 (7 mos]

ACCURACY

PERCENT OF CHECK-CASHING

FILE NO.	CORRECT DATE (DAY MONTH, YEAR)	%%	47.5%	4105	4106
1-1	09	78	73	73	100
1-2	106	87	97	85	88
1-3	118	87	4	73	73
2-1	81	0	0	41	41
2-2	114	87	67	87	73
2-3	150	14	12	37	25
2-4	78	0	0	39	45
2-5	88	14	14	00	28
2-6	101	14	79	29	43
4-1	98	0	14	14	43
4-2	108	78	79	73	100
4-3	148	50	00	00	86
5-1	107	14	07	07	36
5-2	118	28	00	57	100
5-3	112	14	73	86	100
6-1	90	42	87	87	88
6-2	102	14	29	00	100
6-3	102	37	58	00	100
TOTAL		42	48	84	72

CONSISTENCY

PERCENT OF CHECK-CASHING

FILE NO.	AVERAGE DATE (DAY MONTH, YEAR)	%%	47.5%	4106	4106
1-1	87	78	73	73	100
1-2	102	42	87	87	72
1-3	114	87	73	73	73
2-1	106	14	87	87	87
2-2	112	14	87	87	73
2-3	142	42	87	43	71
2-4	88	28	37	71	86
2-5	81	14	29	29	57
2-6	98	28	28	43	73
4-1	118	14	87	87	86
4-2	104	42	73	73	100
4-3	134	42	43	43	86
5-1	118	42	87	87	86
5-2	118	28	14	87	100
6-1	102	42	86	86	100
6-2	94	0	43	43	87
6-3	108	14	29	87	100
TOTAL	106	24	44	66	100
AVERAGE		42	54	64	83

TABLE 12-F

SIZE OF TOWN - OVER 100,000 (11 Men)

ACCURACY

FILM NO.	BEST APPROX. CORRECT RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	98	45	82	91	100
1-2	100	27	36	73	100
1-3	116	45	45	54	100
2-1	88	18	27	27	91
2-2	110	54	73	91	100
2-3	145	27	36	36	100
3-1	77	9	9	9	54
3-2	86	36	54	73	82
3-3	99	9	9	27	73
4-1	103	18	18	27	91
4-2	110	54	82	100	100
4-3	140	37	36	54	91
5-1	104	45	73	73	91
5-2	114	54	82	91	100
5-3	109	64	82	100	100
6-1	101	45	45	64	91
6-2	105	54	64	82	100
6-3	105	27	36	54	100
	AVERAGE	36	49	63	92

CONSISTENCY

FILM NO.	GROUP AVERAGE RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	101	73	91	91	100
1-2	107	64	82	82	100
1-3	107	27	73	73	100
2-1	98	36	64	91	91
2-2	112	73	91	91	100
2-3	138	36	45	64	91
3-1	92	54	54	54	82
3-2	86	36	54	73	82
3-3	88	18	18	45	73
4-1	115	73	73	82	100
4-2	108	73	91	91	100
4-3	132	45	64	64	100
5-1	110	27	36	82	100
5-2	109	54	73	73	100
5-3	108	54	91	100	100
6-1	100	45	45	82	91
6-2	108	54	82	82	100
6-3	102	27	45	45	100
	AVERAGE	48	65	76	95

TABLE 12-7

100,000 (11 Men)

TEAM NO.	BEST ADVANCE. CONSIST RATE	ADV.	47.5%	±CON	±SD
1-1	99	64	84	81	106
1-2	100	67	90	75	100
1-3	118	45	45	94	100
2-1	98	48	47	77	81
2-2	110	54	72	91	100
2-3	140	37	36	98	100
3-1	77	5	6	2	94
3-2	98	64	64	74	84
3-3	[illegible]	0	0	37	77
4-1	102	18	18	87	81
4-2	118	84	88	400	100
4-3	140	37	36	84	81
5-1	104	48	78	72	94
5-2	114	84	48	81	100
5-3	108	64	88	100	400
6-1	101	48	48	84	81
6-2	108	84	84	84	100
6-3	108	37	36	84	100
AVERAGE	28	48	52	93	

CONFIDENTIAL

TEAM NO.	ADVANCE RATE	±SD	47.5%	±CON	±SD
1-1	101	72	84	81	100
1-2	107	54	88	68	100
1-3	107	37	78	73	100
2-1	90	54	84	81	84
2-2	113	72	81	82	100
2-3	128	38	48	84	84
3-1	92	84	84	84	88
3-2	88	18	84	72	88
3-3	84	18	78	48	78
4-1	118	72	72	82	100
4-2	108	72	81	91	100
4-3	128	48	84	84	100
5-1	110	37	38	89	100
5-2	102	84	78	77	100
5-3	108	84	81	100	100
6-1	100	48	48	82	82
6-2	108	84	88	82	100
6-3	102	72	82	82	100
AVERAGE	40	86	78	86	

TABLE 13-A

GROUP RATING BY OWN CONCEPT OF STANDARD PERFORMANCE (55 Men)

ACCURACY

FILM NO.	BEST APPROX. CORRECT RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	98	56	66	73	95
1-2	100	46	47	73	95
1-3	115	47	53	66	97
2-1	86	34	31	38	71
2-2	107	27	51	56	96
2-3	142	31	36	51	93
3-1	77	9	9	20	49
3-2	86	38	51	64	89
3-3	99	16	18	33	73
4-1	95	18	22	51	64
4-2	103	58	78	80	95
4-3	133	33	44	60	93
5-1	105	62	64	78	95
5-2	116	44	47	71	98
5-3	110	53	54	71	100
6-1	102	32	62	62	95
6-2	105	29	51	75	97
6-3	105	55	61	73	97
	AVERAGE	38	47	61	88

CONSISTENCY

FILM NO.	GROUP AVERAGE RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	98	55	56	73	95
1-2	107	46	69	78	95
1-3	109	31	51	88	98
2-1	97	38	51	56	87
2-2	108	25	51	55	96
2-3	134	36	47	51	91
3-1	92	49	58	73	100
3-2	86	38	51	64	89
3-3	87	35	47	49	87
4-1	107	42	62	66	93
4-2	103	58	78	89	95
4-3	123	47	58	62	95
5-1	108	31	71	71	97
5-2	112	36	67	71	98
5-3	111	53	62	89	100
6-1	99	29	47	66	95
6-2	108	31	66	67	98
6-3	105	55	60	73	96
	AVERAGE	40	58	68	95

TABLE 13-A

GROUP RATING BY EACH MEMBER OF 20 ATTACKS PERFORMANCE (15 min.)

AUDITORY

TILE NO.	BEST APPROX. DURATION DATE	%SE	%7.5C	%10C	%20C
1-1	90	56	84	73	96
1-2	100	45	67	73	96
1-3	115	47	62	66	97
2-1	98	54	61	76	71
2-2	107	57	61	86	98
2-3	145	51	50	81	92
3-1	77	0	0	20	46
3-2	85	58	81	64	91
3-3	80	14	16	45	73
4-1	95	13	52	61	84
4-2	102	58	78	80	98
4-3	120	50	64	80	98
5-1	105	98	84	78	98
5-2	110	47	67	71	98
5-3	110	58	84	91	A96
6-1	108	58	89	89	98
6-2	106	50	81	78	97
6-3	105	58	81	73	97
	AVERAGE	48	67	81	88

OCCUPATIONAL

TILE NO.	GROUP AVERAGE DATE	%5C	%7.5C	%10C	%20C
1-1	98	15	76	73	94
1-2	107	40	89	78	96
1-3	109	41	81	85	98
2-1	97	40	81	86	97
2-2	108	58	81	85	96
2-3	124	46	47	81	91
3-1	82	40	58	78	100
3-2	98	58	81	84	86
3-3	97	35	47	49	87
4-1	107	42	82	86	93
4-2	103	60	78	89	96
4-3	108	47	58	83	94
5-1	108	41	72	71	97
5-2	114	46	87	71	98
5-3	121	60	82	89	100
6-1	90	39	47	86	96
6-2	108	41	66	87	90
6-3	105	56	80	78	90
	AVERAGE	40	68	84	95

TABLE 13-B

GROUP RATING BY SOME FILM OR OTHER EMBODIMENT OF STANDARD PERFORMANCE (14 Men)

ACCURACY

FILM NO.	BEST APPROX. CORRECT RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	98	29	50	72	93
1-2	100	36	42	50	86
1-3	116	57	57	72	93
2-1	86	21	29	43	72
2-2	108	29	37	64	86
2-3	142	42	43	50	93
3-1	73	21	21	43	43
3-2	82	14	14	36	72
3-3	94	29	29	57	64
4-1	103	36	50	50	79
4-2	111	57	57	79	100
4-3	142	36	57	72	93
5-1	103	21	43	50	79
5-2	114	64	86	86	93
5-3	108	36	86	86	100
6-1	100	50	50	79	86
6-2	104	36	36	72	100
6-3	104	36	72	72	100
	AVERAGE	36	48	63	85

CONSISTENCY

FILM NO.	GROUP AVERAGE RATE	PERCENT OF GROUP WITHIN ±5%	±7.5%	±10%	±20%
1-1	97	29	43	72	93
1-2	108	36	72	72	93
1-3	110	43	43	93	93
2-1	92	36	36	57	93
2-2	109	29	50	72	86
2-3	133	29	43	79	100
3-1	89	29	29	43	57
3-2	81	14	29	29	79
3-3	82	43	43	72	79
4-1	112	7	38	43	100
4-2	111	57	57	79	100
4-3	134	36	50	57	93
5-1	110	36	36	79	93
5-2	109	50	72	86	93
5-3	107	36	86	86	100
6-1	94	21	57	93	100
6-2	110	50	50	93	100
6-3	105	64	64	93	100
	AVERAGE	36	50	72	93

TABLE 14

OVERALL SUMMARY

ACCURACY					CONSISTENCY			
±5%	±7½%	±10%	±20%		±5%	±7½%	±10%	±20%
				AREA				
31	46	57	86	Nor. Midwest	44	60	72	91
33	45	61	89	Central "	40	59	71	95
34	48	60	84	Southern "	38	57	69	88
44	60	70	93	Michigan	60	74	84	99
				EXPERIENCE				
38	47	56	81	0-6 months	38	55	62	84
36	48	60	90	6 mos.-2 yrs.	38	58	70	94
36	46	62	88	2-4 years	38	55	66	93
33	48	59	87	Over 4 years	42	56	70	94
				PLACE OF TRAINING				
34	52	60	87	College	35	50	61	93
36	45	59	88	Company	43	54	69	94
				NUMBER OF EMPLOYEES				
35	47	61	90	Under 200	39	47	64	88
37	51	61	91	200 - 1000	44	60	73	95
28	43	57	89	Over 1000	36	53	65	93
				RATING CONCEPT				
38	47	61	88	Own concept	40	58	68	95
36	48	63	85	Film or other	36	50	72	92
				SIZE OF TOWN				
35	50	61	89	Under 5,000	43	58	74	95
39	50	59	85	5,000-10000	36	57	72	97
34	47	59	85	10000-25000	32	52	66	88
34	58	62	94	25000-50000	46	68	82	98
33	43	52	79	50000-100000	32	54	58	82
36	49	63	92	Over 100000	48	65	76	95
				TOTAL GROUP				
33	48	58	89		39	55	64	94

TABLE 14

OVERALL RANKING

| # | ABILITY | | |

TABLE 15

RESULTS OF ANALYSIS OF VARIANCE TEST

	ACCURACY			CONSISTENCY		
	±5%	±7½%	±10%	±5%	±7½%	±10%
Geographical Area	1.78	1.85	.31	5.22	3.75	3.89
	Critical Values:			4.08 at 1% level 2.78 at 5% level		
Place of Initial Time Study Tra.	.09	1.41	.02	.06	.88	2.09
	Critical Values:			7.44 at 1% level 4.13 at 5% level		
No. of Employees in Plant	3.10	.88	.26	.75	2.63	1.34
	Critical Values:			5.06 at 1% level 3.18 at 5% level		
Size of Town	.27	.73	.50	3.77	2.01	4.56
	Critical Values:			3.20 at 1% level 2.30 at 5% level		
Method of Rating	.14	.01	2.69	1.29	2.20	.48
	Critical Values:			7.44 at 1% level 4.13 at 5% level		
Experience	.21	.04	.24	.33	.20	.80
	Critical Values:			4.08 at 1% level 2.74 at 5% level		

TABLE 18

SENSITIVITY OF ANALYSIS TO VARIANCE DATA

	ADVERSITY			CONSERVATISM		
	+5%	+25%	+10%	+5%	+25%	+10%
Occupational Type	1.79	1.80	.71	4.39	3.76	3.89
Optimal Values:				4.08 at 1% level 3.78 at 5% level		
Time Study Ttn. Plans of Initial	.08	1.45	.98	.06	.58	2.59
Optimal Values:				7.88 at 1% level 4.12 at 5% level		
No. of Employees In Plant	1.10	.85	.25	.76	4.69	1.84
Critical Values:				5.04 at 1% level 3.38 at 5% level		
Type of Term	.87	.78	.80	1.77	6.07	4.50
Critical Values:				7.80 at 1% level 5.20 at 5% level		
Method of Rating	.14	.01	3.65	1.09	3.80	.48
Optimal Values:				7.41 at 1% level 4.12 at 5% level		
Experience	.81	.05	.84	.13	.80	.80
Critical Values:				4.08 at 1% level 3.76 at 5% level		

BIBLIOGRAPHY

Barnes, Ralph M., Motion and Time Study, 3rd edition, New York: John Wiley & Sons, Inc., 1949

Barnes, Ralph M., "What Has Been Done to Improve Rating Operator Performance," Proceedings of the National Time and Motion Study Clinic, November, 1945.

Borrus, Bernard S., "The Present State of Time Study," Unpublished Master's Thesis, Purdue University, Lafayette, Indiana, 1950.

Carrol, Phil, Time Study for Cost Control, New York: McGraw - Hill Book Company, Inc., 1938.

Editors, "Progress Report of the Committee on Rating of Time Studies," Advanced Management, VI, September, 1941.

Hoel, Paul G., Introduction to Mathematic Statistics, New York: John Wiley & Sons, Inc., 1947

Lockett, Lawrence S., "An Evaluation of Time Study Ratings of a Synthetic Task," Unpublished Master's Thesis, Purdue University, Lafayette, Indiana, 1950.

Lowry, Steward M., Harold B. Maynard, G. J. Stegenerten, Time and Motion Study and Formulas for Wage Incentives. New York: McGraw-Hill Book Company, Inc., 1932.

Margolin, Louis, "A Comparison of Two Methods of Presentation for Time Study Rating," Unpublished Master's Thesis, Purdue University, Lafayette, Indiana, 1948.

Mundel, Marvin E., Systematic Motion and Time Study. New York: Prentice-Hall, Inc., 1947

Presgrave, Ralph, Dymanics of Time Study, 2nd edition, New York: McGraw-Hill Book Company, Inc., 1945.

Tiffin, Joseph, Industrial Psychology, New York: Prentice Hall, Inc., 1947.

BIBLIOGRAPHY

Barnes, Ralph M., Motion and Time Study, 7th edition, New York: John Wiley & Sons, Inc., 1968.

Barnes, Ralph M., "What Time Does Have to Improve Motion Operator Performance," Proceedings of the Twelfth Time and Motion Study Clinic, 1965.

Borrus, Norman S., "The Present State of Time Study," Unpublished Master's Thesis, Purdue University, Lafayette, Indiana, 1950.

Dartel, Carl, Time Study for Every Country, New York: McGraw - Hill Book Company, Inc., 1929.

Eilon, "Progress report of the Committee on Motion of Time Study," Management Engineering, VI, September, 1961.

Hoel, Paul G., Introduction to Differential Statistics, New York: John Wiley & Sons, Inc., 1947.

Longwell, Lawrence S., "An Examination of Time Study Ratings of a Synthetic Task," Unpublished Master's Thesis, Purdue University, Lafayette, Indiana, 1950.

Lowry, Stewart M., Harold B. Maynard, G. J. Stegemerten, Time and Motion Study and Formulas for Wage Incentives, New York: McGraw-Hill Book Company, Inc., 1932.

Matyoun, Louis, "A Comparison of Two Methods of Tradeoff for Time Study Rating," Unpublished Master's Thesis, Purdue University, Lafayette, Indiana, 1968.

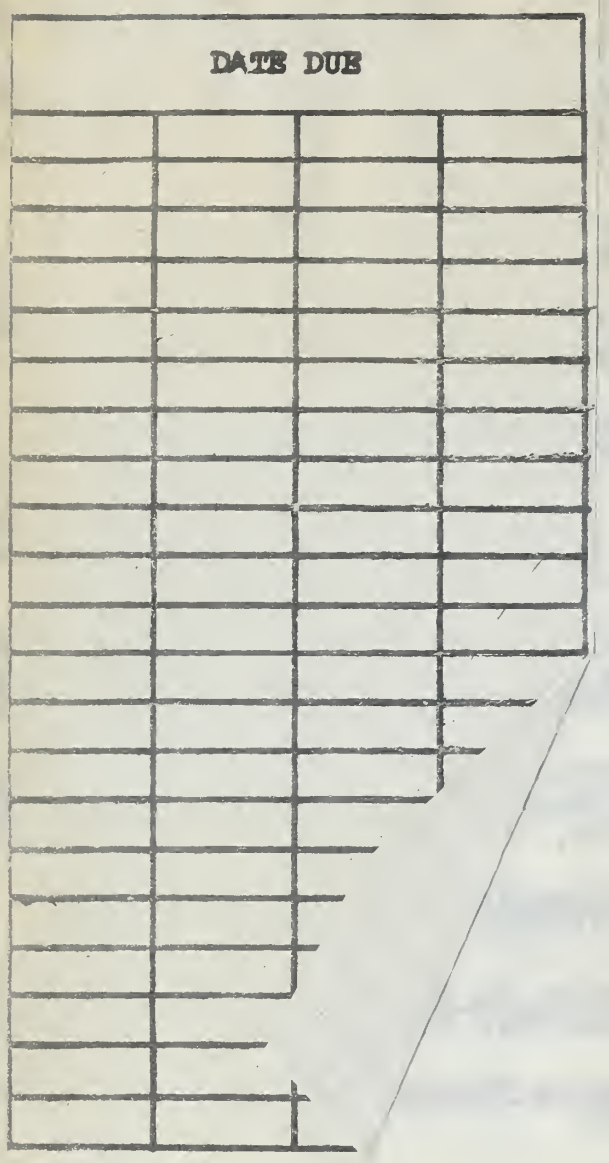
Maynard, Harold B., Industrial Engineering Handbook, New York: McGraw-Hill Book Company, Inc., 1956.

Niebel, Benjamin W., Motion and Time Study, 5th edition, New York: John Wiley & Sons, Inc., 1968.

Nadler, Gerald, Work Design, Homewood, Illinois: Richard D. Irwin, Inc., 1963.

Presgrave, Ralph, Dynamics of Time Study, New York: McGraw-Hill Book Company, Inc., 1923.

Tiffin, Joseph, Industrial Psychology, New York: Prentice Hall, Inc., 1947.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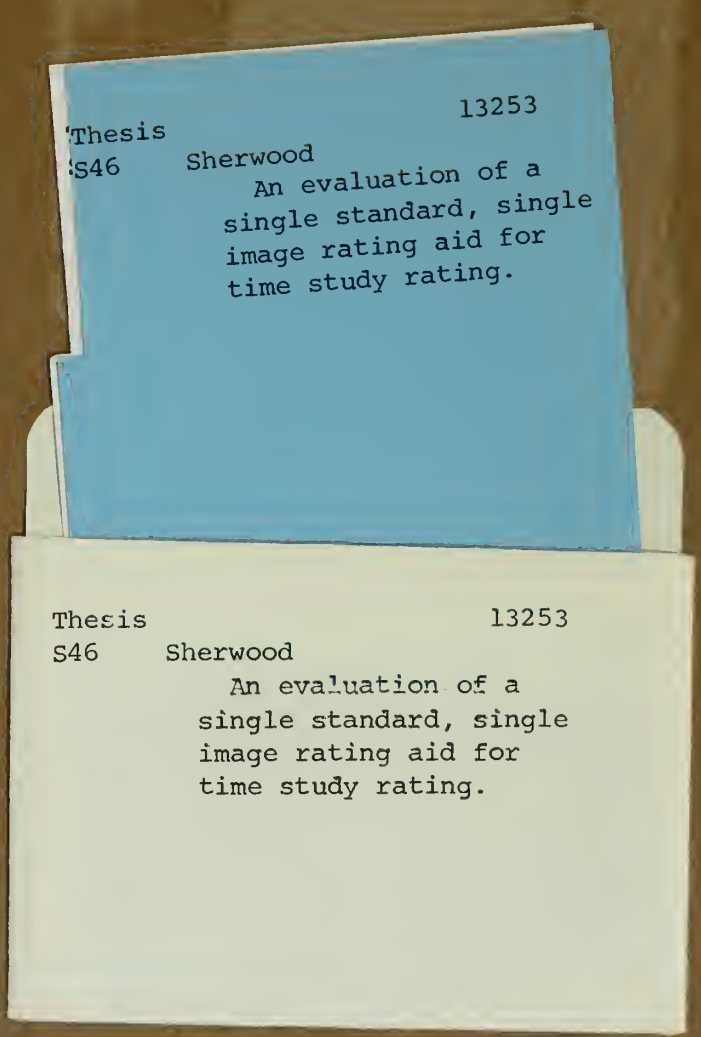
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An evaluation of a single standard, single image rating aid for time study rating.
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